Function generator 1 mHz – 20 MHz
PM 5134

Instruction manual
Gerätehandbuch
Mode d'emploi et d'entretien

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Sixth Edition
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PHILIPS

Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s. v. p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit etre assuré par du personnel qualifié. De meme, l'entretien et les réparations sont à confier aux personnes suffisamment qualifiées.

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1. GENERAL

1.1. INTRODUCTION

The PM 5134 is an easy-to-use yet sophisticated function generator embodying a wide range of facilities in a single instrument.

It produces sine, square and triangle wave forms as well as positive or negative pulses and DC. The duty cycle is variable between 10% and 90%.
The 1mHz to 20MHz frequency range is selected by means of a 10-position rotary switch with an overriding coarse/fine adjustment. This fine adjustment, combined with the 3 1/2 digit LED display, gives an immediate, highly accurate readout of the selected frequency.

Setting up procedures are thus very much simplified compared with the traditional dial setting and any human errors (e.g. paralax) are eliminated.

In addition, the 3 1/2 digit display can be used to monitor the open-circuit output voltage. Also, when used in the sweep mode, the start, stop and run frequencies are indicated by separate LEDs. Moreover, an error warning lamp automatically indicates any incompatible setting-up conditions.

The high , nominal accuracy of ±2% ±1 digit, can be further improved to $\pm 5 \times 10^{-6}$ by operating the instrument in the crystal-control mode. This facility is useful, for example, for identical repetitive measurements requiring high accuracy, or for narrow band filter tests. The X–TAL AM mode offers a stable carrier wave with defined frequency. One particular application is when using a 10.7 MHz carrier frequency to check that the discriminator section of a radio receiver is suppressing the AM wave form.

The continuously variable 20Vpp max output (10Vpp for pulses) is available at the front panel socket; there is a pushbutton choice of 600Ω or 50Ω output impedance. The output attenuation is selectable in any combination of 3-6-10-20dB pushbuttons with an overriding continuous 20dB control.

Sweep facilities include single and continuous operation. The single sweep can be triggered either manually, or electronically from an external source. The sweep period is continuously adjustable between 5ms and 100s. The START and STOP frequencies are non-interactive and can be set independently of each other. A HOLD facility allows a sweep to be stopped at any desired frequency – useful for checking phenomena occurring during a sweep – by means of a pushbutton. An interrupted sweep is continued by simply releasing the HOLD button. If required a sweep can be reset to the start frequency using the RESET pushbutton.

The generator offers an internally or externally controlled burst or single-cycle signal. The start/stop phase is continuously adjustable between -90° and $+90^{\circ}$.

The internal AM is adjustable between 0 and 100% modulation depth. The modulation frequency can be set over a wide range from 10mHz to 20kHz. The AM facility can be used with crystal control, if desired. External AM inputs in the range from DC to 20kHz can be applied via a rear-mounted BNC-socket.
The internal FM can be continuously adjusted between zero and ±10% frequency deviation.

Other input/output facilities available on the rear panel include a TTL output and pen lift control.

The design of the PM 5134 has resulted in a clean, simple front panel layout which allows the operator to become quickly familiar with all control functions. Its overall versatility makes it suitable for a wide range of applications within research, design or educational organisations. The instrument occupies minimal bench space.

1.2. TECHNICAL DATA

Safety characteristics

This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains some information and warnings which must be followed by the user to ensure safe operation and to retain the apparatus in a safe condition.

Performance characteristics, specifications

Properties expressed in numerical values with stated tolerance are guaranteed by the manufacturer. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.

This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23 °C).

If not stated otherwise, relative or absolute tolerances relate to the set value.

1.2.1. Frequency

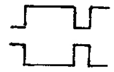
frequency range	1 mHz – 20 MHz	
selected ranges I	1 mHz – 20 mHz	
II	10 mHz – 200 mHz	
III	0.1 Hz – 2 Hz	
IV	1 Hz – 20 Hz	
V	10 Hz – 200 Hz	
VI	100 Hz – 2 kHz	±2%
VII	1 kHz – 20 kHz	
VIII	10 kHz – 200 kHz	
IX	100 kHz – 2 MHz	
X	1 MHz – 20 MHz	±5%
for X–TAL mode ranges IV – X only	1 Hz – 20 MHz	
characteristic	linear	
adjustments	– range switch FREQ RANGE – FREQUENCY knobs for coarse and fine setting – pushbutton X–TAL LOCK/TUNE	
vernier frequency adjustment	±5% of end of range	
display	3 1/2 digit 7-segment LED display 3 decimal points 4 LEDs for dimensions mHz, Hz, kHz, MHz	
setting error	range I to IX: ±2% ±1 digit X: ±5% ±1 digit	
– for X–TAL mode	$\pm 5 \cdot 10^{-6}$	
temperature coefficient	range I to IX: < 0.1%/K X: < 0.3%/K	
– for X–TAL mode	$< 2 \cdot 10^{-6}$/K	
short-term drift	range I to IX: < 0.1% X: < 0.4 %	within 15 min
– for X–TAL mode	range IV to IX: $< 1 \cdot 10^{-6}$ X: $< 5 \cdot 10^{-6}$	within 15 min

long-term drift	range I to IX: < 0.3 % ; X: < 0.6 % — within 7 h
– for X–TAL mode	$< 0.5 \cdot 10^{-6}$ — within 7 h

1.2.2. Output

connection	BNC socket
impedance	50Ω/600Ω, selected by pushbutton
load capability	short-circuit proof
wave forms	∿ sine wave triangular wave square wave positive pulse negative pulse all with or without DC offset; DC d.c. voltage without a.c.
duty cycle	continuously adjustable from 10% to 90% when pushbutton DUTY CYCLE is pressed; in range X not possible
amplitude, open circuit	2 Vpp . . . 20 Vpp for sine, triangle, square wave 1 Vpp . . . 10 Vpp for pulses
– limit	±10 V (for details see chapter 3.2.3.)
– display	3 1/2 digit 7-segment LED display, alternative to frequency display, selected by pushbutton AMPL/FREQ, step attenuation ignored
– display error	±3% of end of range, at 1 kHz sine and square wave
DC (offset) voltage, open circuit	continuously adjustable from –5 V to +5 V, when pushbutton DC OFFSET pulled
attenuation	
– continuous	0 . . . 20 dB (see open circuit voltage 2 Vpp . . . 20 Vpp)
– fixed	0, 3, 6, 10, 20 dB, selectable in any combination
amplitude response (sine wave; reference value 2 kHz)	< 0.1 dB in ranges III to VIII < 0.5 dB in ranges I to IX < 1.5 dB in range X (open circuit voltage 20 Vpp, attenuator 0 dB, output impedance 50 Ω, load 50 Ω)
distortion (sine wave)	< 0.5% in ranges IV to VIII < 3.0% in ranges I to IX 3% ≙ -30,46 dB range X: all harmonics more than 26 dB below the fundamental
linearity (triangular wave)	better than 99% up to 100 kHz
rise time, fall time (square wave)	< 18 ns at max. amplitude, into 50Ω
overshoot and ringing (square wave)	< 3% at max. amplitude, into 50Ω

1.2.3. TTL OUTPUT

frequency, duty cycle	as main output, duty cycle referred to 'active low':  main OUTPUT TTL OUTPUT
fan out	5 TTL inputs
level	standard TTL level: high > 2.4 V low < 0.8 V
external voltage	not proof against external voltage > 5 V

1.2.4. Sweep, internal

operating modes	– single sweep, manually started by pushbutton TRIG – single sweep, electronically started via TRIG & BURST input – continuous sweep
max. sweep range	2 decades
sweep characteristic	linear
start frequency	continuously coarse and fine adjustable within the selected sweep range; displayed when pushbutton STD BY is pressed
stop frequency	identical to the frequency setting in normal mode both frequencies are independently adjustable; the start frequency may be set higher or lower than the stop frequency
display	as for normal mode (start or stop frequency); 3 LEDs for STOP, RUN, START in addition
sweep period range	5 ms to 100 s, adjustable in 4 sub-ranges
– sub-ranges	0.005 – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
sweep control elements	– pushbutton TRIG to start a single sweep – pushbutton HOLD to stop the running sweep immediately – pushbutton RESET for resetting during the sweep to the start frequency
sweep indication	LED 'RUN'
sweep voltage at MODULATION OUTPUT	BNC socket at the rear side
– output voltage	0 V . . . +5 V ($\hat{=} f_{START} \ldots f_{STOP}$)
– impedance	10 kΩ

PEN LIFT OUTPUT	BNC socket at the rear side; electronic switch, closed during the sweep, open during fly-back
	max. current: 200 mA; output voltage: < 0.7 V } electronic switch closed
	output voltage: +20 V; internal resistance: 100 kΩ } electronic switch open

1.2.5. Frequency control, external

SWEEP/FM INPUT	BNC socket at the rear side for external control signal for normal mode
voltage vs. frequency characteristic	linear, 1 V/0.2 f_{max}, where f_{max} represents the upper limit of the corresponding sub-range
max. sweep range	2 1/2 decades
max. sweep frequency	200 Hz for a sweep of 1 1/2 decades; sweep voltage: sawtooth, duty cycle 90%
modulation frequency range	DC to 20 kHz, adjustable as MOD/PERIOD $>$ 0.05 ms
input impedance	5 kΩ
TRIG & BURST INPUT	BNC socket at the rear side for external trigger signal for single sweep
– trigger signal	negative going edge from $\geqslant$ +2.2 V to $\leqslant$ 0.8 V, e.g. H/L transition of a TTL signal
– max. input voltage	±15 V
– input impedance	1 TTL input

1.2.6. Burst control, internal

	in ranges I to IX
operating modes	repetitive or single triggering
duty cycle, repetitive operation	≈ 50%; each burst is terminated at the start/stop level
repetition time, repetitive operation	0.05 ms to 100 s, continuously adjustable within 6 sub-ranges MOD/SWEEP PERIOD
– sub-ranges	0.05 – 1 ms 0.5 – 10 ms 5 ms – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
burst duration for single operation	as repetition time for repetitive operation
single triggering	manually (internal) or electronically via TRIG & BURST INPUT as for internal sweep

	start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90° to $+90^{\circ}$)
	voltage at MODULATION OUTPUT	TTL-high level: during burst period TTL-low level: during off period
	– impedance	250 Ω (pull-up)
1.2.7.	**Burst control, external**	in ranges I to IX
	TRIG & BURST INPUT	for external TTL signal; at L/H transition the burst starts; after H/L transition the last cycle is terminated at the start/stop level on the positive slope
	max. control frequency	2 MHz
	max. input voltage	±15 V
	input load	1 TTL input
	start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90° to $+90^{\circ}$)
1.2.8.	**SINGLE MODE**	in ranges I to IX
	triggering	
	– manually	with pushbutton TRIG
	– electronically	via TRIG & BURST INPUT or internal repetitive
	repetition period for internal triggering	0.05 ms to 100 s; continuously adjustable within 6 sub-ranges MOD/SWEEP PERIOD
	– sub-ranges	0.05 – 1 ms 0.5 – 10 ms 5 ms – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
	start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90° to $+90^{\circ}$)
	voltage at MODULATION OUTPUT	TTL-high level: during single period TTL-low level: during off period
	output impedance	250 Ω (pull-up)
	max. trigger frequency	2 MHz for external triggering
	external trigger voltage	TTL level
	max. input voltage	±15 V
	max. input load	1 TTL input

1.2.9. Modulation

Frequency modulation, internal	sine wave
modulation depth	0 to 10%, continuously adjustable
modulation frequency	0.01 Hz to 20 kHz, continuously adjustable within 6 sub-ranges (reciprocal to the modulation period: 100 s - 10 s - 1 s - 0.1 s - 10 ms - 1 ms)
modulation voltage at MODULATION OUTPUT	3 Vpp, independent of depth
– output load	1 kΩ
Amplitude modulation, internal	sine wave
modulation depth	0 . . . 100%, continuously adjustable
modulation frequency	0.01 Hz to 20 kHz, continuously adjustable within 6 sub-ranges (reciprocal to the modulation period: 100 s - 10 s - 1 s - 0.1 s - 10 ms - 1 ms)
modulation voltage at MODULATION OUTPUT	3 Vpp, independent on AM depth
– output load	1 kΩ
Amplitude modulation, external	
modulation wave form	arbitrary with spectral components up to 20 kHz
modulation frequency	DC to 20 kHz
modulation depth	0 to 2 A_{Tr}, A_{Tr} $\hat{=}$ unmodulated carrier amplitude
modulation voltage	2 Vpp for 50% AM
connector	BNC socket AM INPUT, rear side
– input impedance	20 kΩ, internal modulator switched off

1.2.10. X–TAL MODE

X–TAL MODE	ranges IV to X
frequency setting and display	as for NORMAL MODE, if AMPL/FREQ is unlocked
frequency lock with pushbutton LOCK/TUNE	freezes the instant frequency display
settling time	< 3 s for ranges V to X < 30 s for range IV
X–TAL AM MODE	as X–TAL MODE with additional internal or external AM facility

1.2.11.	**Error indication** for unallowed operating modes	LED 'ERROR' indicates unallowed settings, see chapter 3.2.7
1.2.12.	**Power supply**	ac mains
	reference value	220 V
	nominal values	110 V/128 V/220 V/238 V, selectable by solder links
	nominal operating range	±10% of selected nominal value
	operating limits	±10% of selected nominal value
	nominal frequency range	50 - 60 Hz
	limit range of operation	47.5 - 63 Hz
	power consumption	55 W
1.2.13.	**Environmental conditions**	
	Ambient temperature:	
	reference value	+23° C ±1 K
	nominal working range	+ 5° C . . . +40° C
	limits for storage and transport	−40° C . . . +70° C
	Relative humidity:	
	reference range	45 . . . 75%
	nominal working range	20 . . . 80%
	limit range of operation	10 . . . 90%
	limits for storage and transport	0 . . . 90%
	Air pressure:	
	reference value	1000 ± 15 hPa
	nominal working range	798 . . . 1064 hPa
	Air speed:	
	reference value	0 . . . 0.2 m/s
	nominal working range	0 . . . 0.5 m/s
	Operating position	normally upright on feet or with handle fold down
	Warm-up time	30 min.
1.2.14.	**Cabinet**	
	protection type (see DIN 40 050)	IP 20
	protection class (see IEC 348)	class I, protective conductor
	overall dimensions	
	– height	140 mm
	– width	310 mm
	– depth	390 mm
	weight	approx. 6.5 kg (14 lbs)

1.3. ACCESSORIES

1.3.1. Standard

instruction manual
fuse
labels for power supply

1.3.2. Optional

PM 9585: 50Ω termination 1 W
PM 9581: 50Ω termination 3 W
PM 9075: Coaxial connection cable BNC-BNC 75Ω
PM 9051: Adapter BNC (male) – Banana (female)

1.4. OPERATING PRINCIPLE (Fig. 30)

The functional block modulation oscillator control controls the integrator and the modulation sine shaper according to the actual operating mode.

When the switch MODE is set to SWEEP and the button STD BY/CONT is pressed, the start frequency of the main oscillator can be adjusted. When the button TRIG is operated or triggered by an appropriate pulse at the socket TRIG & BURST, the integrator begins one cycle of a saw-tooth voltage. Analogous to this, the frequency of the main oscillator continuously runs to the adjusted STOP-frequency and quickly flies back to the START frequency.

This process can also be initiated by locking out the STD BY/CONT button; but then the integrator generates a sawtooth voltage periodically repeated. The integrator can be stopped at any value by the button HOLD respectively can be set back to the start-condition with the button RESET. The duration of the period of the sawtooth voltage can be adjusted by the switch MOD/SWEEP PERIOD and the potentiometer PERIOD.

During the forward ramp of the sawtooth voltage, an electronic contact in the modulation oscillator control is "closed" which connects the socket PEN LIFT to ground. During fly-back the connection is open.

In positions FM, AM, and X–TAL AM of the switch MODE the integrator generates a zero-symmetrical triangular voltage, which is converted to a sine wave in the modulation sine shaper. The depth respectively the degree of the modulation are adjustable by the AM/FM DEPTH potentiometer.

In the positions BURST and SINGLE, the main oscillator can be controlled with the TTL-signal of the integrator via the burst control.

According to the operating mode the applied control voltage (saw-tooth or square wave) of the modul. oscillator is fed to the socket MODULATION OUTPUT.

All values controlling the frequency of the main oscillator are combined by the control section to one internal control voltage, being proportional to the frequency.
According to the operating mode, this voltage is dependent on the position of the potentiometer STOP FREQ or START FREQ, on the sweep or FM-voltage of the modulation oscillator, and on the external voltage at the socket SWEEP/FM. The controlling voltage is digitized –when the AMPL / FREQ–key is not pressed– by the analog to digital converter ADC and is displayed as a frequency. The control section provides two charging currents for the main oscillator which are proportional to the driving voltage. When the DUTY CYCLE button is pressed and when the potentiometer DUTY CYCLE is adjusted correspondingly, the charging currents have different values and are variable. Their ratio determines the duty-cycle of the signal generated by the main oscillator. Within the frequency range of 20 MHz the duty cycle is not changeable.

The integration capacitors comprises the frequency-determining capacities of the main oscillator. They are selected by the FREQ RANGE switch.

The triangular voltage of the main oscillator is lead directly via the switching stages to the output channel. The square-wave voltage must be processed for further use in the signal conditioner. The outputs of this functional block are routed to the output TTL, to x-tal control, to the square wave generator and the burst control.

By means of the burst control the SINGLE and BURST functions of the main oscillator are controlled. If the trigger input of the BURST control has switched over to TTL-high level, the main oscillator is able to run free; if the trigger input is set to TTL-low level, the main oscillator is blocked after reaching the chosen Start/Stop phase. The signals are generated by the modulation generator; the signals may also be applied to the input TRIG & BURST.

The square-wave generator forms –dependent upon the adjusted WAVE FORM– a zero-symmetric square-wave voltage or positive or negative square-wave pulses out of the square-wave voltage of the signal conditioner.
The triangular voltage is switched by the WAVE FORM switch either to the sine shaper or to the buffer. With the operating mode AM and X–TAL AM of the switch MODE, the amplitude modulator is switched into the signal path.
Modulation is effected with the voltage of the modulation oscillator or with an external voltage at the socket AM.

The voltage adjusted at the regulator AMPLITUDE is amplified by the power amplifier to a maximum of 20 Vpp. This alternating voltage can be superimposed with a direct current by the potentiometer DC OFFSET.

The attenuator operated by the switches ATTENUATION allows an exact reduction at choice within the combinable stages 3, 6, 10 and 20 dB. The inner resistance of the OUTPUT can be switched over via the button 600 Ω/50 Ω in the 600 Ω/50 Ω selector.

Tandem potentiometer AMPLITUDE causes the ampl display conditioner to produce a d.c. voltage being proportional to the amplitude. When the AMPL/FREQ button is pushed this voltage is indicated as open-circuit voltage of the generator. The indicated values of the voltage for pulse signals or AM mode are half as big as for zero-symmetrical signal wave forms. This is organized by the WAFE FORM switch in the ampl display conditioner.

In the display, the LEDs of the dimension and status indication, and also the decimal points in the 7-segment display units are controlled by the LED control. The X–tal control circuit is only switched on by the switch MODE in the X–TAL operating modes.

The frequency indicated by the display is stored in the memory. When the button X–TAL LOCK is pressed, these contents are fixed; thus a possible jumping of the last digit is inhibited. When the button AMPL/FREQ is pressed, amplitude indication is chosen and the last indicated frequency stays stored in the memory.

In the operating modes X–TAL the frequency of the main oscillator exactly corresponds to the value indicated by the display.
The generation of the charging current in the control section is controlled in this case by the output of the summing amplifier. This adds the roughly graduated output voltage of the DAC and the output voltage of the phase detector and integrator which alters finely. The output voltage of the DAC corresponds to the 6 most significant bits of the contents of the memory. The range between two adjacent voltage steps is overlapped by the regulating voltage of the phase detector & integrator. The nominative actual comparison, the result of which is the regulating voltage, is performed according to two different processes. The block diagram shows the position of the switch in the frequency ranges of 20 Hz to 20 kHz, this will be looked into the following.

The actual frequency of the main oscillator sensed at the signal conditioner passes the first variable prescaler I without being divided and arrives at an input of the phase detector and integrator. The nominal frequency is generated in a PLL-system. In this system the programmable frequency divider divides the output frequency of the functional block phase detector and integrator and VCO by the contents of the memory loaded by the ADC. In the steady state, the output frequency of the programmable frequency divider is equal to the 200 Hz frequency of the x-tal stabilized reference oscillator. The controlled VCO-frequency is thus the memory contents multiplied by 200 Hz.

In the second variable prescaler II the VCO frequency is divided according to the chosen FREQ RANGE. From there it is switched to the nominal frequency input of the phase detector and integrator. The capacities of the integrator are switched over dependent on the frequency range. The regulating voltage results from the direct phase comparison between actual and nominal frequency and the consecutive integration.

In the frequency ranges 200 kHz to 20 MHz the x-tal control switches take over the position not depicted. Then the phase detector & integrator & VCO and the second variable prescaler II are out of action. The actual frequency is divided dependent on the range by the variable prescaler I, the output frequency of which is divided by the programmable frequency divider by the contents of the memory. The result is compared by the phase detector & integrator with the nominal frequency at the 100 Hz output of the reference oscillator.
The regulating voltage originates in this case out of the phase comparison between the actual frequency which is divided down to 100 Hz in its steady state and the 100 Hz nominal frequency.

The power supply provides the d.c. voltages for the circuitries and the supply voltage for the fan.

The unit is switched on and off with the switch POWER.

2. INSTALLATION INSTRUCTIONS

2.1. INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occurred during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

2.2. SAFETY INSTRUCTIONS

Upon delivery from the factory the instrument complies with the required safety regulations, see para. 1.2. To maintain this condition and to ensure safe operation, the instructions below must carefully be followed.

2.2.1. Maintenance and repair

Failure and excessive stress:
If the instrument is suspected of being unsafe, take it out of operation permanently.
This is the case when the instrument
- shows physical damage
- does not function anymore
- is stressed beyond the tolerable limits (e.g. during storage and transportation)

Dismantling the instrument: When removing covers or other parts by means of tools, live parts or terminals could be exposed. Before opening the instrument, disconnect it from all power sources.

If the **open live instrument needs calibration, maintenance or repair,** it must be performed only by trained personnel being aware of the risks. After disconnection from all power sources, the capacitors in the instrument may remain charged for some seconds.

2.2.2. Earthing (grounding)

Before any other connection is made the instrument shall be connected to a protective earth conductor via the three-core mains cable. The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.
The external contacts of the BNC sockets must not be used to connect a protective conductor.

WARNING:	Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

The circuit earth potential applied to the external contacts of the BNC sockets is connected to the cabinet. The external contacts of the BNC sockets must not be used to connect a protective conductor.

2.2.3. Connections

The circuit earth potential is applied to the external contacts of the BNC sockets and is connected to the cabinet by means of parallel-connected capacitor and resistor. By this means hum loops are avoided and a clear HF earthing is obtained.
If the circuit earth potential in a measurement set-up is different from the protective earth potential, it must be noticed,
- that the BNC sockets can be touched and that it must not be live, see the safety regulations on the subject (VDE 0411),
- that all sockets marked with the sign ⊥ are internally interconnected.

2.2.4. Mains voltage setting and fuses

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.
The instrument shall be set to the local mains voltage only by a qualified person who is aware of the hazard involved.

WARNING:	If the mains plug has to be adapted to the local situation, such adaption should be done by a qualified person only.

Make sure that only fuses of the required current rating, and of the specified type, are used for renewal. The use of repaired fuses, and/or the short-circuiting of fuse holders, are prohibited.
The fuse shall be renewed only by a qualified person who is aware of the hazard involved.

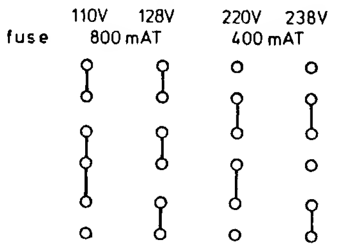
WARNING:	The instrument shall be disconnected from all voltage sources when a fuse is to be renewed, or when the instrument is to be adapted to a different mains voltage.

2.3. MAINS VOLTAGE SETTING AND FUSES

The safety instructions in chapter 2.2.4. must be followed.

On delivery from the factory the instrument is set to 220 V (PM 5134) resp. 110 V (PM 5134 M).
If the instrument is to be used on a different supply voltage proceed as follows:

- Unplug the mains connector
- Fold up the handle to the top.
  For this push the buttons of the handle.
- Loosen the central screw at the rear
- Dismantle the cabinet
- Change the solder links
  according to the connection diagram on the bottom side of the instrument



- If necessary exchange the supplied fuse and mains voltage label
- Close the instrument

2.4. OPERATING POSITION OF THE INSTRUMENT

The instrument may be used in the positions indicated in clause1.2.13.With the handle folded down, the instrument may be used in a sloping position; for this push the buttons of the handle. The characteristics mentioned in Section 1.2. are guaranteed for the specified positions.
Ensure that the ventilation holes in the cover are free of obstruction.
Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight.

2.5. DISMANTLING THE INSTRUMENT

- Unplug the mains connector
- Fold up the handle to the top. For this push the buttons of the handle
- Loosen the central screw at the rear
- Dismantle the cabinet

2.6. RADIO INTERFERENCE SUPPRESSION

Radio interference of the instrument is suppressed and checked carefully. In connection with deficient suppressed base units and further units radio interference can be generated, which have to be suppressed by means of additional activities.

3. OPERATING INSTRUCTIONS

3.1. CONTROLS AND SOCKETS (Fig. 31, 32, 37)

Legend	Position	Function
POWER	83	mains switch:
○ ON ● OFF		white dot for ON position
WAVE FORM	87	signal wave form, rotary switch
FREQ RANGE Hz	85	frequency ranges, rotary switch
FREQUENCY START	601/1-2	start frequency } for SWEEP mode;
FREQUENCY STOP	602/1-2	stop frequency } double potentiometer
	602/1-2	frequency adjustment for the other operating modes (MODE)
	409, 411 412, 413	7-segment LED display
AMPL/FREQ	803/U2	measuring mode for the digital display, pushbutton
mHz, Hz, kHz, MHz	357-360	indication of the frequency range, LEDs
Vpp	361	indication of amplitude measurement, LED
ERROR	362	indication of wrong operating mode, LED
STOP, RUN, START	354-356	state of internal sweep, LED
DUTY CYCLE	82/2 603	duty cycle switch, pushbutton duty cycle control, potentiometer
ATTENUATION	802/1-4	fixed attenuation, pushbutton array
AMPLITUDE	608	variable attenuation, tandem potentiometer
DC OFFSET PUSH FOR ZERO	604	DC offset, if pulled; push-pull-switch with potentiometer
50 Ω/600 Ω	82/3	output impedance, pushbutton
OUTPUT	807	output connection, BNC connector at the front side
MODE	84	operating mode, rotary switch
X—TAL LOCK/TUNE	82/1	x-tal frequency control locked or free, pushbutton
MOD/SWEEP PERIOD s	86	period range for modulation or sweep mode, rotary switch
PERIOD	606	variable period, potentiometer
HOLD	81/1	sweep hold, pushbutton
RESET	81/2	sweep reset, pushbutton
STD BY/CONT	81/3	stand by/continuous operation, pushbutton
TRIG	81/4	trigger, pushbutton
AM/FM DEPTH	607	degree or depth of modulation, potentiometer
START PHASE	605	phase control for burst trigger or single pulse trigger, potentiometer
MODULATION OUTPUT	804	output modulation signals BNC
TTL OUTPUT	805	output TTL signal BNC
PEN LIFT OUTPUT	806	pen lift control signal BNC
		at the rear side

Legend		Position	Function	
SWEEP/FM	INPUT	801	external sweep or FM signal	BNC at the rear side
AM	INPUT	802	external amplitude modulation	BNC at the rear side
TRIG & BURST	INPUT	803	external trigger	BNC at the rear side

3.2. OPERATION

3.2.1. Setting the wave form

The required wave form, sine, triangular, square wave, positive or negative pulses is selected by the WAVE FORM switch. If the duty cycle of the output signal shall be set to a value different to 50%, the pushbutton DUTY CYCLE must be pressed allowing the required value to be set by the DUTY CYCLE control. In the 20 MHz range this action is not possible being indicated by ERROR, see 3.2.7.

At the socket TTL OUTPUT a TTL signal is available, corresponding to the inverted signal at the OUTPUT socket.

3.2.2. Setting the frequency, see also short-form instruction 3.2.6.1.

The following elements serve for
frequency adjustment:

- the FREQ RANGE switch, decadal stepped
- the continuously and independently operating STOP and START controls; double potmeters with different sensitivities for convenient operation
- the digital frequency and automatic dimension display
- the ERROR indicator for unallowed combinations of frequency and duty cycle settings

The stop frequency is adjusted in NORMAL mode by means of the STOP control with pre-set frequency range. In the same range with chosen SWEEP mode, the START control serves for adjusting the start frequency. The start frequency may be higher or lower than the stop frequency.

Note: In X–TAL or X–TAL AM mode the displayed frequency is used as reference value for the oscillator frequency. To avoid frequency hopping caused by least significant digit switching of the display, pushbutton X–TAL LOCK should be activated after setting the desired frequency.
If the modulation/sweep oscillator is not used, it should be switched off, switch to STD BY.
Further more, when pushbutton AMPL/FREQ is pressed, the last indicated value of the frequency is locked and there will be no change by turning the frequency potmeters.

3.2.3. Setting the OUTPUT voltage, see also short-form instruction 3.2.6.2.

The amplitude of the output signal is continuously adjustable by means of the AMPLITUDE control. With AMPL/FREQ button pressed, this value, p-p, is digitally displayed.

Pulled button DC OFFSET enables a continuously adjustable positive or negative d.c. voltage to be added to the output signal.

With WAVE FORM switch in position DC, the a.c. part of the output signal is switched off and the d.c. voltage only is fed to the output.

With step attenuator ATTENUATION, the output signal including the DC offset can be attenuated in any combinable steps of 3 dB, 6 dB, 10 dB and 20 dB.

With the 600Ω/50Ω pushbutton the required output impedance can be selected.

Note: The output amplifier could be overdriven due to adding signal and DC offset voltage. To avoid limiting, the peak value of the open-circuit output voltage must not exceed ±10 V (step attenuator set to 0 dB).

3.2.4. **Setting the internal sweep,** see also short-form instruction 3.2.6.3.

During the SWEEP PERIOD a sweep within one frequency sub-range is linearly performed from the START to the STOP frequency.

The sweep period can be selected in sub-ranges and is fine adjustable.

Starting a single sweep is done by pressing the pushbutton TRIG or by a trigger pulse (H/L edge e.g. of a TTL signal) at the TRIG & BURST INPUT. Continuous sweep is realized by unlocking the pushbutton STD BY/CONT.

The MODULATION OUTPUT socket at the rear side provides the momentary sweep voltage corresponding to a distinct signal frequency for controlling an oscilloscope or x - y plotter. The voltage to frequency relationship is linear; a sweep voltage of 0 V represents f_{START}, a sweep voltage of +5 V f_{STOP}.

Further elements for manual control are

– the HOLD pushbutton to stop the sweep immediately

– the RESET pushbutton for resetting to f_{START} during the sweep.

Note: Before executing an internal sweep, disconnect all cables from the SWEEP INPUT socket. This input is not switched off during an internal sweep.

3.2.5. **External sweep and frequency modulation,** see also short-form instruction 3.2.6.3.

A voltage at the SWEEP/FM INPUT socket modulates the frequency of the generator. The required basic frequency is adjusted by means of the FREQ RANGE switch and the STOP control. The frequency varies proportionally to the d.c. or a.c. voltage at the socket.

The maximum frequency variation may not exceed 2 1/2 decades, whereby the actual upper frequency limit is also valid as sweep limit, which should not be overdriven because of signal distortion due to overdriving the current source.

3.2.6. BURST and SINGLE

After switching from STD BY to CONT BURST or CONT SINGLE the first period (repetition time) differs from the following. These following periods correspond to the adjusted time.

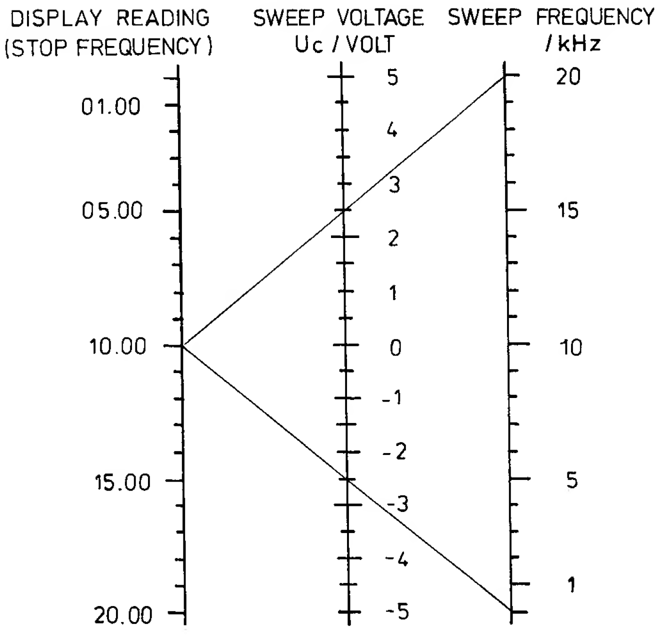


Fig. 1 External sweep;
sweep range vs. sweep control voltage Uc;
example for range VII (1 kHz - 20 kHz)

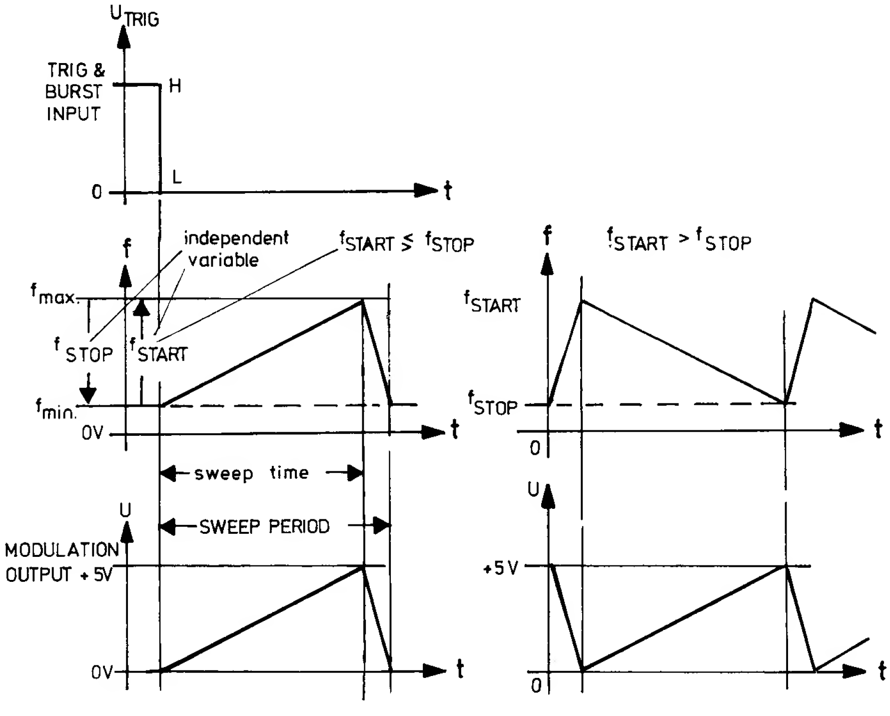
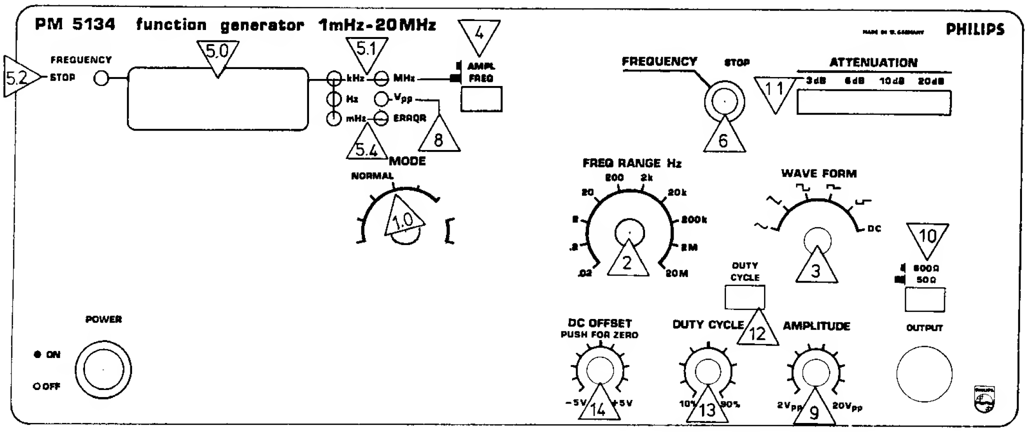
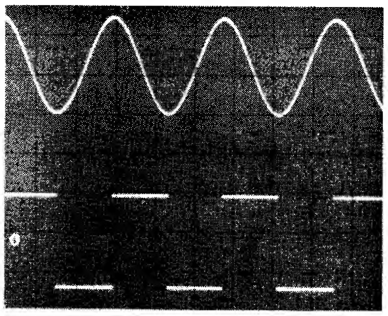
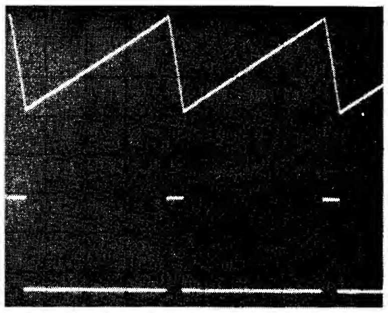


Fig. 2 Sweep mode




Sine wave output signal and corresponding TTL signal

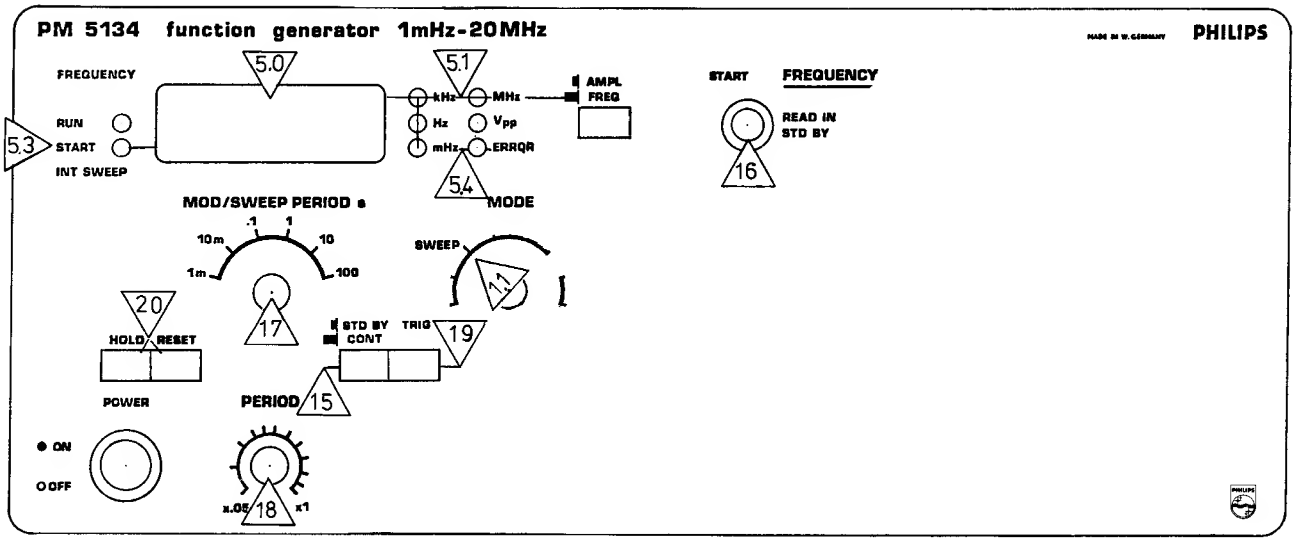

Variable duty cycle shown in triangular and square wave signal

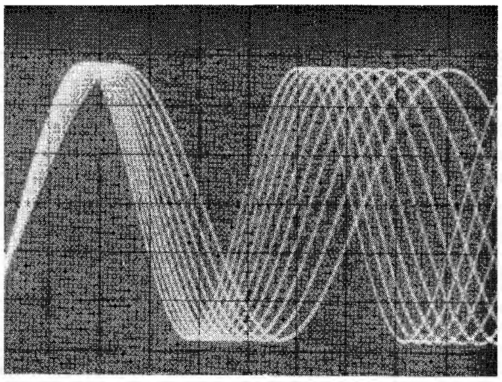
3.2.6.1. NORMAL mode

1.0	Set to NORMAL
2	select frequency range
3	choose signal wave form
4	if necessary, unlock AMPL/FREQ button
5.0 5.1	displayed frequency lies within the chosen frequency range with respect to the indicated dimension
5.2	indication STOP lights
6	set (coarse/fine) the required frequency by means of the double control STOP

3.2.6.2.

4	push AMPL/FREQ button
8 5.0	Vpp indicates voltage measurement; the display indicates the open circuit amplitude at the input of the attenuator
9	set AMPLITUDE to the required value
10	select output impedance
11	choose ATTENUATION
12	if required, push DUTY CYCLE button
13	adjust the duty cycle by means of the DUTY CYCLE control
5.4	ERROR indicator lights in the 20 MHz frequency range, if DUTY CYCLE pushbutton is pressed
14	if required, pull switch DC OFFSET for adding a d.c. offset to the a.c. signal and adjust the OFFSET by means of the control





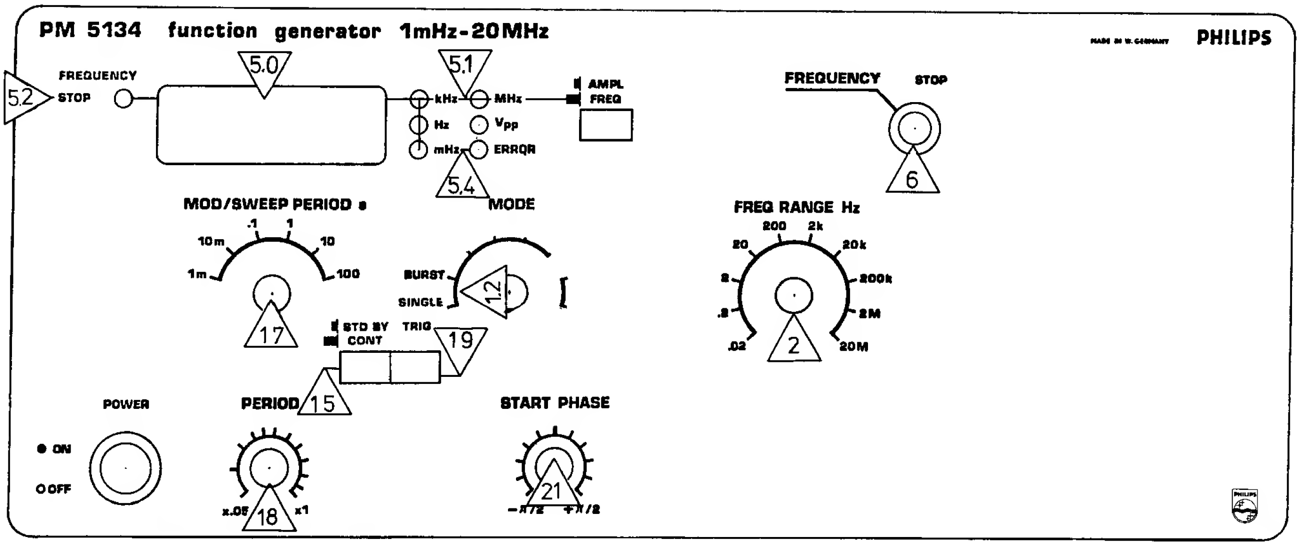
Oscillogram showing frequency sweep

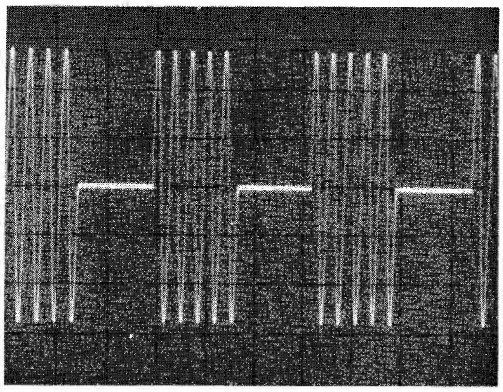
3.2.6.3. SWEEP mode

Adjust STOP frequency in NORMAL mode, see 3.2.6.1.

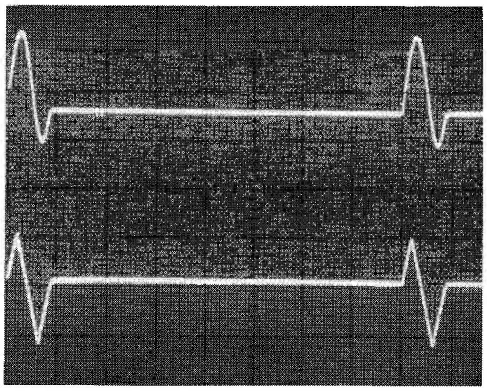
1.1	set to SWEEP
15	set sweep generator to STD BY
5.3	START frequency indication lights
16	adjust required start frequency by coarse/fine START control
17	choose SWEEP PERIOD range
5.4	ERROR indication for SWEEP PERIOD ranges 1 m, 10 m
18	adjust required period time with PERIOD control
15	start the sweep by unlocking the pushbutton or:
19	start by pushing the button or by external trigger signal
20	ir required, HOLD or RESET the sweep

If necessary, check and correct the settings of the output signal according to 3.2.6.2.





Burst signal



Single facility shown with different start phase between sine wave and triangular wave

3.2.6.4. BURST or SINGLE mode

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

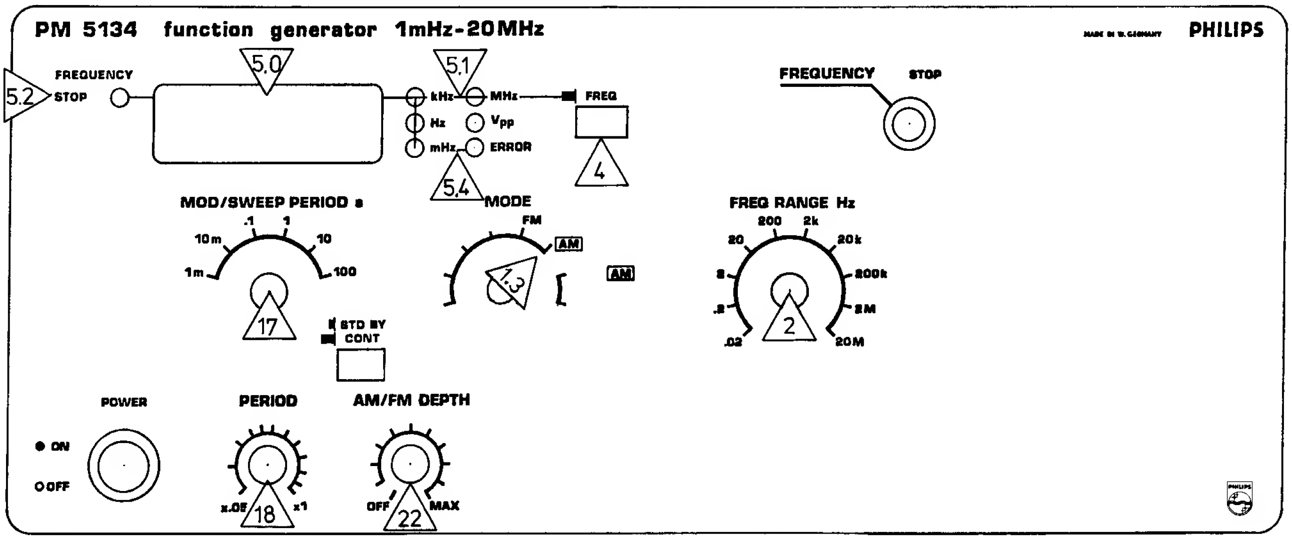
1.2	set to SINGLE or BURST
5.4	ERROR indication (flashing) for 20 MHz range
5.2	STOP frequency is indicated
17	choose range of repetition period or burst duration
18	adjust repetition period or burst duration
21	adjust start phase
15.2	start periodical operation by unlocking the pushbutton or:
19.1	start single operation by pushing the TRIG button or by external trigger signal

If necessary, check and correct the settings of the output signal according to 3.2.6.2.

3.2.6.4.1. External BURST

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

1.0	set to NORMAL
2	apply external square wave signal (TTL level) to socket TRIG & BURST (see 1.2.7.)
21	adjust start/stop phase

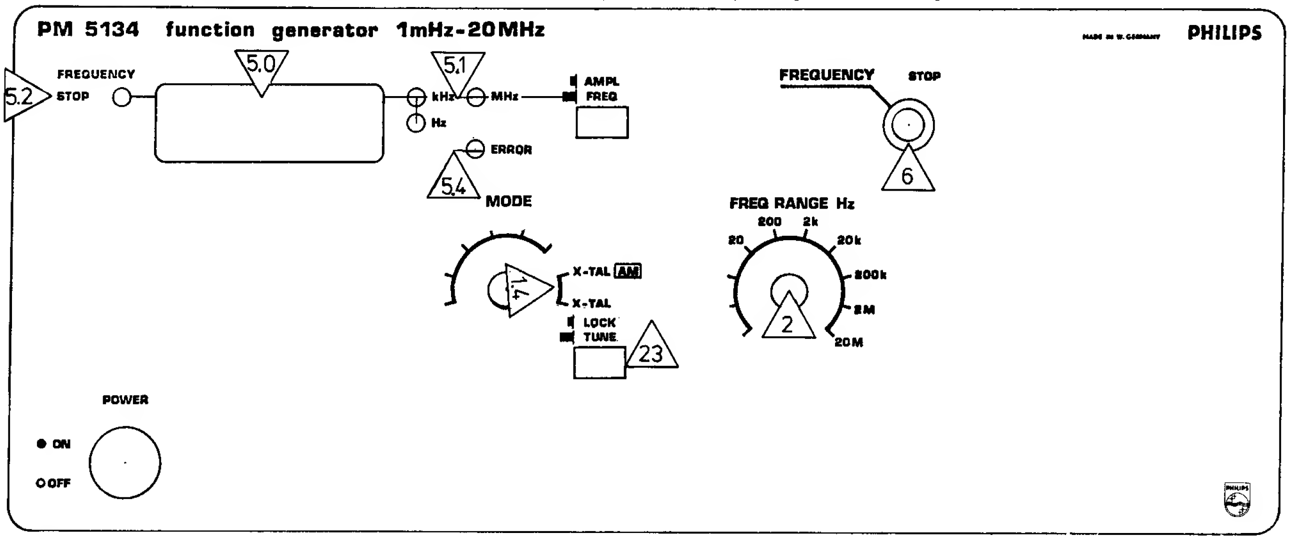


3.2.6.5. FM mode; AM or (X – TAL) AM

Adjust carrier frequency as STOP frequency in NORMAL mode, see 3.2.6.1.

1.3	set to FM or AM or X–TAL AM (if necessary unlock AMPL/FREQ pushbutton)
5.2	STOP frequency is indicated (if necessary, unlock STD BY pushbutton)
5.4	ERROR indication for X–TAL AM in ranges .02/.2/2 Hz or frequency settings < 0100
17	choose modulation frequency range
18	adjust modulation frequency
22	adjust AM factor or frequency deviation or set to OFF for external AM

If necessary, check and correct the settings of the output signal according to 3.2.6.2.



3.2.6.6. X–TAL or X–TAL (AM)

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

1.4	set to X–TAL or X–TAL AM
23	push LOCK/TUNE button and so freeze display and frequency
5.4	ERROR indication for positions 0.02/.2/2 Hz or frequency settings < 0100

3.2.7. Error indication

In order to have a quick indication of unallowed setting of frequencies, frequency ranges and duty cycle the LED indicator ERROR flashes. The unallowed combinations of settings are shown in the following table:

MODE	MOD/SWEEP PERIOD s	FREQ RANGE Hz	Display
SWEEP	1 ms; 10 ms		
SINGLE; BURST		20 MHz	
X–TAL; X–TAL AM		.02/.2/2 Hz	
X–TAL; X–TAL AM			< 0100
DUTY CYCLE		20 MHz	

Please note: In X–TAL mode, when pushbutton AMPL/FREQ is pressed, the last indicated value of the frequency is locked and there will be no change by tuning the frequency potmeters.

3.2.8. Frequency indication at the upper range limits

The normal upper limit of the frequency ranges is indicated by 2000 on the display. Actually the display range is limited to 2048 due to the digital voltmeter component in the display circuitry.
Turning the frequency potmeters above 2048 does not effect the display.

Service part

4.1. CIRCUIT DESCRIPTION PM 5134

4.1.1. Modulation generator, see figs. 4.1 - 1 and 41

The modulation generator generates input voltages for the control section. In SWEEP mode sawtooth voltages (10 Vpp) and in BURST and SINGLE CYCLE mode square wave signals (5 Vpp) are generated. The modulation generator mainly consists of the integrator 219 with input FETs 146 and charging capacitors 431 - 435, comparator 151/152, current switch 148/149, regulator 144/145 and square wave switch 218. The potmeter PERIOD determines the square wave output voltage of OP 218 which is fed via range resistors 712 - 714 to the integrator.
The modulation generator is set to sweep mode by closing all 4 MOS– switches 222 controlled by transistors 157/158.

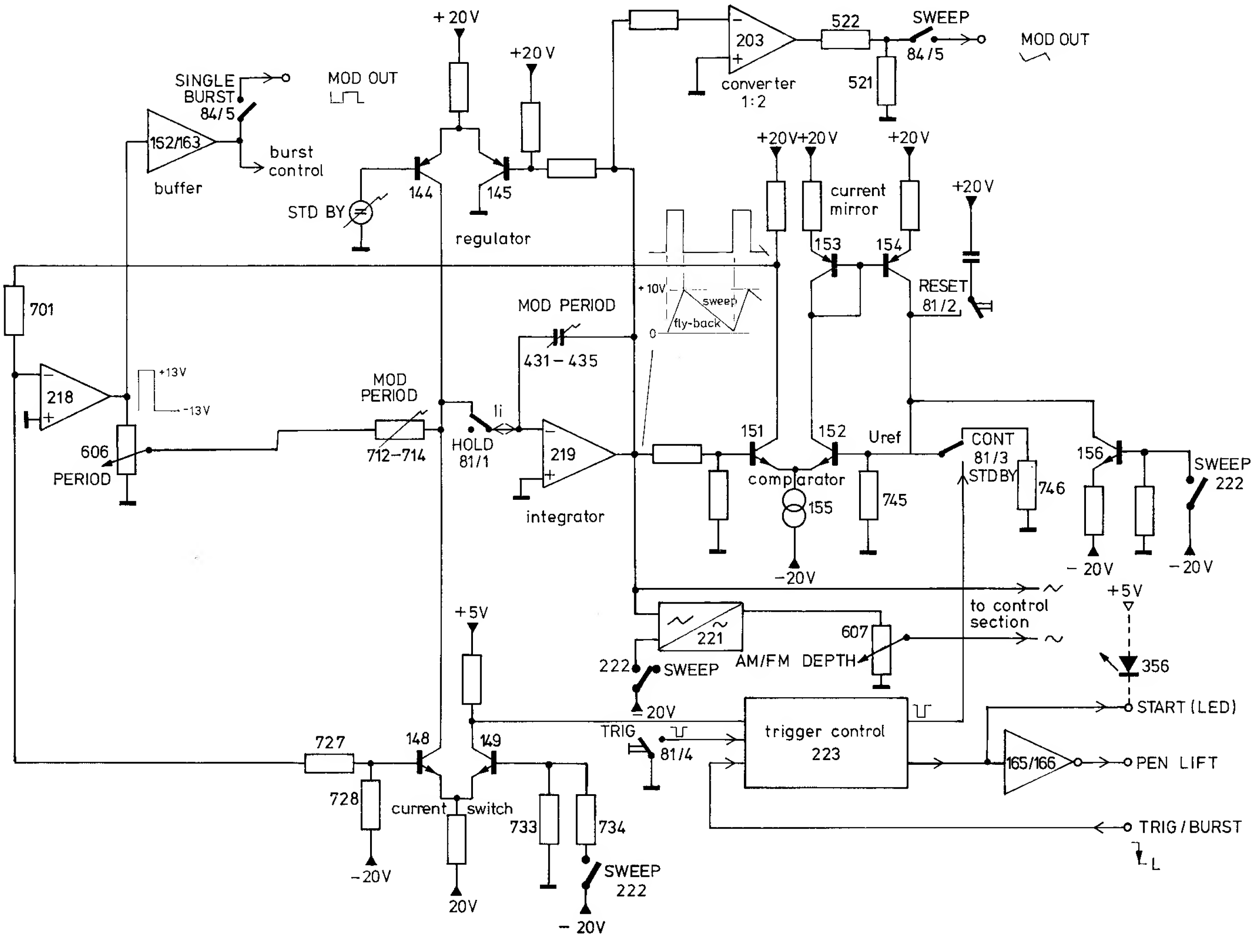


Fig. 4.1 - 1 Modulation generator

In continuous **SWEEP mode** a positive voltage is applied to the input of the integrator, resulting in a negative going ramp from 10 V to 0 V at the output of the integrator. The reference level Uref of the comparator at the base of transistor 152 is set to 0 V. When the integrator output voltage reaches 0 V, transistor 151 is turned off and transistor 148 is turned on. Simultaneously the collector current of transistor 155 is routed via transistor 152 and the current mirror 153/154 to resistors 745/746 establishing a reference voltage of about 4.8 V. In consequence of the high collector current of transistor 148 the integrator now quickly flies back to +10 V. At this level the comparator turns over to the initial state and a new cycle starts.

In **STAND BY** mode the positive reference level of comparator 151/152 during fly-back phase of the integrator is increased by switching off resistor 746 to 6 V. Hence the comparator 151/152 can't switch over, when the integrator output voltage arrives at 10 V. This integrator output level is now fixed by a regulator circuitry comprising 144/145. By switch 81/3 the -13 V output voltage of 218 is connected to 704, lowering the base voltage of 144 to about 15 V. When the integrator output voltage reaches 10 V the base voltage of 145 approaches 15 V too; so transistor 144 becomes conducting. The collector output current thus will balance the integrator input current 219. By this way the integrator output voltage is stabilized to 10 V.

When pressing pushbutton **TRIG** only one integrator sawtooth cycle is initiated. A negative pulse is applied to the reference input of comparator 151/152 via trigger control 223 and the comparator is switched over from its STAND BY position. Furthermore triggering is possible by an external TTL signal on the falling edge via input TRIG & BURST.

When pressing pushbutton **RESET** a positive pulse is fed to the reference input of the comparator, switching over the comparator and initiating fly-back.

In **HOLD** mode current to the integrator is switched off by SK 81/1 and the integrator remains at its instantaneous output voltage.

Indication of the sweep status is done by the LEDs RUN and START.
In **STAND BY** mode transistor 149 is switched off. Hence collector voltage is high. This high level is inverted to low by 223.2.3 and fed to the LED control circuitry 406, 417 and 420. Additionally, high level from mode switch 84 is applied to the LED control circuitry. Hence during stand-by and sweep the corresponding LEDs are activated. The output of gate 223.2 is additionally applied to inverting circuitry transistors 165/166 for PEN LIFT OUTPUT.

In SWEEP mode the integrator output voltage slope is inverted by amplifier 203, attenuated by resistor 521:522 to 5 Vpp and fed to the MODULATION OUTPUT socket.

In all modes except SWEEP the integrator generates symmetrical triangular wave forms (5 Vpp). This is achieved by FET switches 222 which are turned off. The output current of current source 155 is halved resulting in 2.5 Vpp instead of 4.8 Vpp for sweep mode at the comparator reference input. Additionally, current source 156 is switched on, hence the two reference voltages become symmetrical with respect to zero. Therefore the switch over function of the comparator is performed at ±2.5 V integrator output voltage. Stand-by is inhibited as 148 is turned off and 144 can't be turned on by 145.

The integrator input current is derived from the saturation output levels 218, which are nearly symmetrical with respect to zero. Therefore a triangular integrator output voltage results. This voltage is applied to the **modulation sine shaper** comprising 159, 221 and 161. The distortion factor is set to minimum by potmeter 721, 769 and 772. The sine shaper output voltage is attenuated by the AM/FM DEPTH potmeter 607 and routed via 84/6 to the input amplifier 203 of the control section. Additionally, the sine wave voltage is applied to the MODULATION OUTPUT socket via SK 84/5.

4.1.2. **Control section**, see figs. 4.1 - 2, 41, 42

The **general task** of the control section is to generate charging currents for the main oscillator. Inputs of this circuitry are the wiper voltages of the start and stop frequency potmeter, the output voltage of the modulation generator and the external sweep or modulation signal. These voltages are converted into the output currents Ip and In. The conversion characteristic is linear.

In **NORMAL mode** the input of the amplifier 203 is set to ground; so the start potentiometer is not active. As the output of the amplifier is U = 2 Ur - Usweep, where Ur = +5 V, +10 V are applied to the potmeter 602 for the (stop) frequency setting. The voltages at the wipers are converted into currents via resistors 529 to 533 and summed up at the input of amplifier 205. This current is transferred by transistor 102 to 536, 537 establishing the control voltage Uc for the following voltage to current converters.

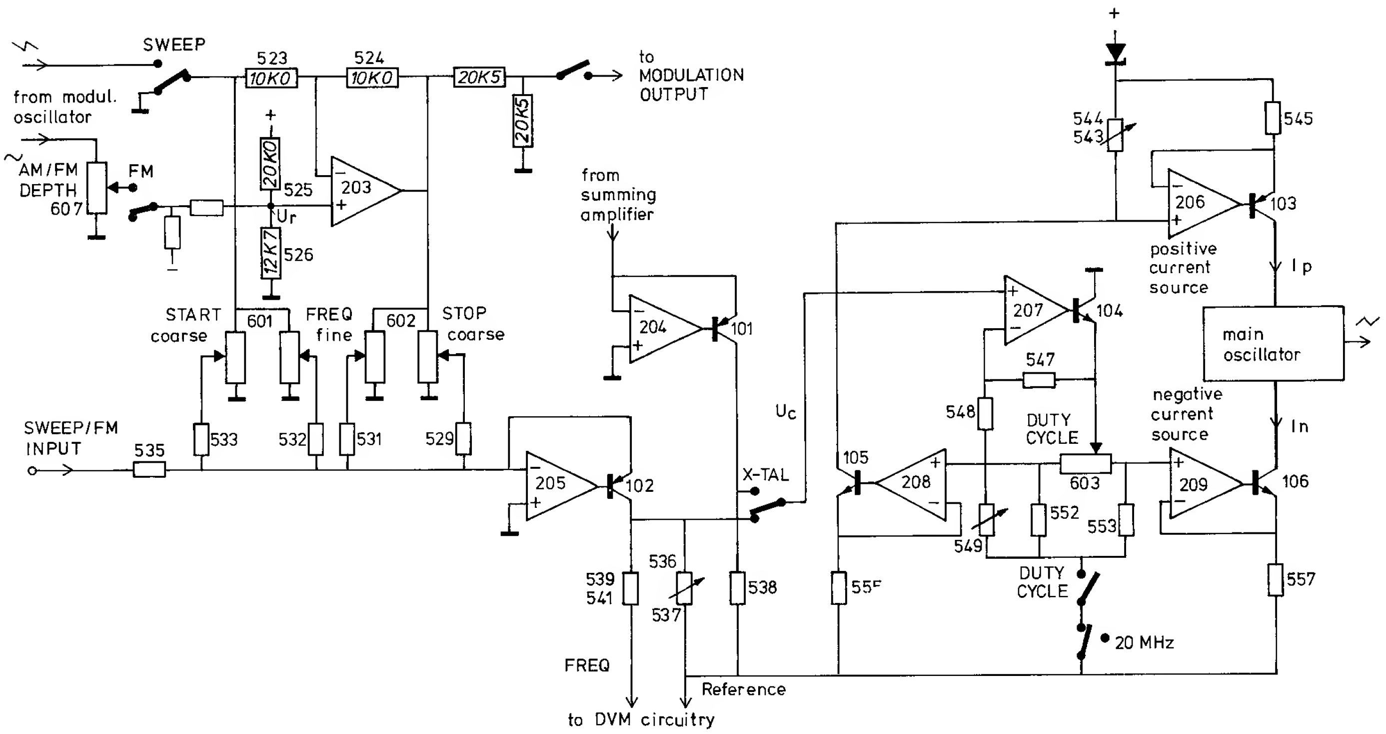


Fig. 4.1 - 2 Control section

When DUTY CYCLE is not pressed potmeter 603 is not active. Control voltage Uc is passed 1 : 1 via impedance converter OP 207/transistor 104 to the **negative current source,** comprising amplifier 209 and transistor 106 and to the auxiliary current source 208/105. The output current of 208/105 is fed to resistor 543/544, establishing a control voltage for the **positive current source** 206/103. The output current Ip is identical with In. Current range is from 0.5 mA to 10 mA in each frequency subrange.

In order to vary the **duty cycle** of the main oscillator signal the ratio Ip/In must be altered. Additionally the condition 1/Ip + 1/In = constant must be satisfied to get no frequency change. For the total setting range of the duty cycle each current (Ip, In respec.) is varied from 0.56 I to 5I where I = Ip = In for normal mode or 50 % duty cycle respectively.
Variation of Ip/In is controlled by potmeter 603 when the DUTY CYCLE button is pressed. In this situation Uc is amplified by the amplifier 207 and divider 547 - 549. The output voltage 5 Uc is applied to potmeter wiper 603. In central position of 603 this voltage is decreased to Uc again by divider 603, 552 or 603, 553 respectively and applied to the current converter 209/106 and 208/105 resulting in Ip = In = I. In the end positions of 603 the resulting control voltages of the current converters are 0.56 Uc and 5 Uc, vice versa. The corresponding output currents are Ip = 0.56 I and In = 5 I, vice versa. In the 20 MHz range the duty cycle function is switched off.

In **SWEEP mode,** stand-by state, +10 V output from the modulation oscillator is applied to amplifier 203 and to start potentiometer 601. Hence 0 V at the amplifier output and stop potmeter 602 is resulting. Thus 602 is inactive. During the sweep the modulation oscillator voltage represents a negative going ramp. Hence the voltages at the potmeters 601/602 are mutually decreasing and increasing until at the end of the sweep 602 is active only as in normal mode, thus defining the stop frequency.

In the **FM mode** a sine wave voltage is added to Up resulting in a superimposed sine wave voltage on 10 V d.c. at potmeter 602. Thus Ip and In of the control section get sinusoidal portions modulating the main oscillator frequency.

4.1.3. Main generator, see figs. 4.1 - 3, 42, 43

The main oscillator generates a symmetrical triangular voltage of 5 Vpp. It operates on the relaxation oscillator principle whereby a capacitor is first linearly charged in one direction and then linearly charged in the reverse direction. The frequency is determined by the selected range capacitor and the charging current, generated by the control section.

Switchover of the charging current is achieved by a transistor switching circuit controlled by a two-level detector or comparator at two predetermined voltage levels of the integrating capacitors.

The circuit operates as follows:
Assume that point 'a' is positive. The integration capacitor will charge via transistor 111 and 112 (109 and 113 are switched off). At a predetermined level, transistor 124 of the comparator will switch on. So transistors 123, 125 and 121 are cut off, resulting in a negative reference voltage of the comparator at resistor 615 and in no load current Ia. The quadruple switch circuit will switch over. The capacitor will now be charged in the reverse direction via transistors 109 and 113. At a negative predetermined level, transistor 124 will switch off and open transistors 123, 125 and 121 again. So point 'a' is positive again and a new cycle starts. In this way, a triangular wave is generated, the frequency of which depends on the charging capacitor, the charging current and the signal amplitude.

The basic part of the oscillator is the **quadruple switch** with the frequency determining capacitors, selected by the front-panel pushbuttons FREQ RANGE Hz. Under the control of the square wave signal at point 'a', at each half-cycle two diagonal opposite transistors open while the other two close (i.e. 111, 112 open, 109, 113 close, vice versa). In this way the direction of the charging current is alternating.

The **main oscillator** generates a time-symmetrical output voltage. For 50 % duty cycle signals of the generator the charging currents Ip and In must be equal. Asymmetrical wave forms are generated, if these charging currents are differing. This is dependant from the duty cycle settings. The symmetry of the triangular output voltage with respect to zero is resulting from switch over voltages of the comparator 124/125. The loading currents Ip/In vary between 0.5 mA and 10 mA for all ranges.

For the 20 MHz range the integration capacitors 373 and 392 are active only. For the ranges 2 MHz — 200 Hz capacitors 393 — 403 are switched in. In order to reduce the value and so the size of the capacitors for the 4 lowest frequency ranges (20 mHz — 20 Hz) the capacitors are substituted by an **active integration** circuitry comprising OP 213/214 and capacitors 404 — 407. By this circuitry the effective capacity is 10^4 times higher than the integrator capacity. Adjustment is done by potmeter 629, 631, 632.

A high impedance FET **buffer** 115 avoids charging current leakage at the charging capacitor. Emitter followers 117/118 then connect the signal to the comparator.

To compensate for non-linearity in the frequency response in the higher ranges due to delays in the oscillator loop a **lead circuit** is inserted between oscillator and comparator, whereby 384/385 mainly in the 20 MHz range, 612/387 in the 2 MHz range and 611/386 mainly in the 200 KHz range are active.

The **comparator** 124/125 compares the instantaneous value of the capacitor charging potential against the reference level at the base 125 which is Ur = ±0.27 V representing symmetrical square wave. When the base 124 attains one of the reference levels, the comparator actuates the quadruple switch. At the same time, the comparator reference level is switched to the opposite polarity.

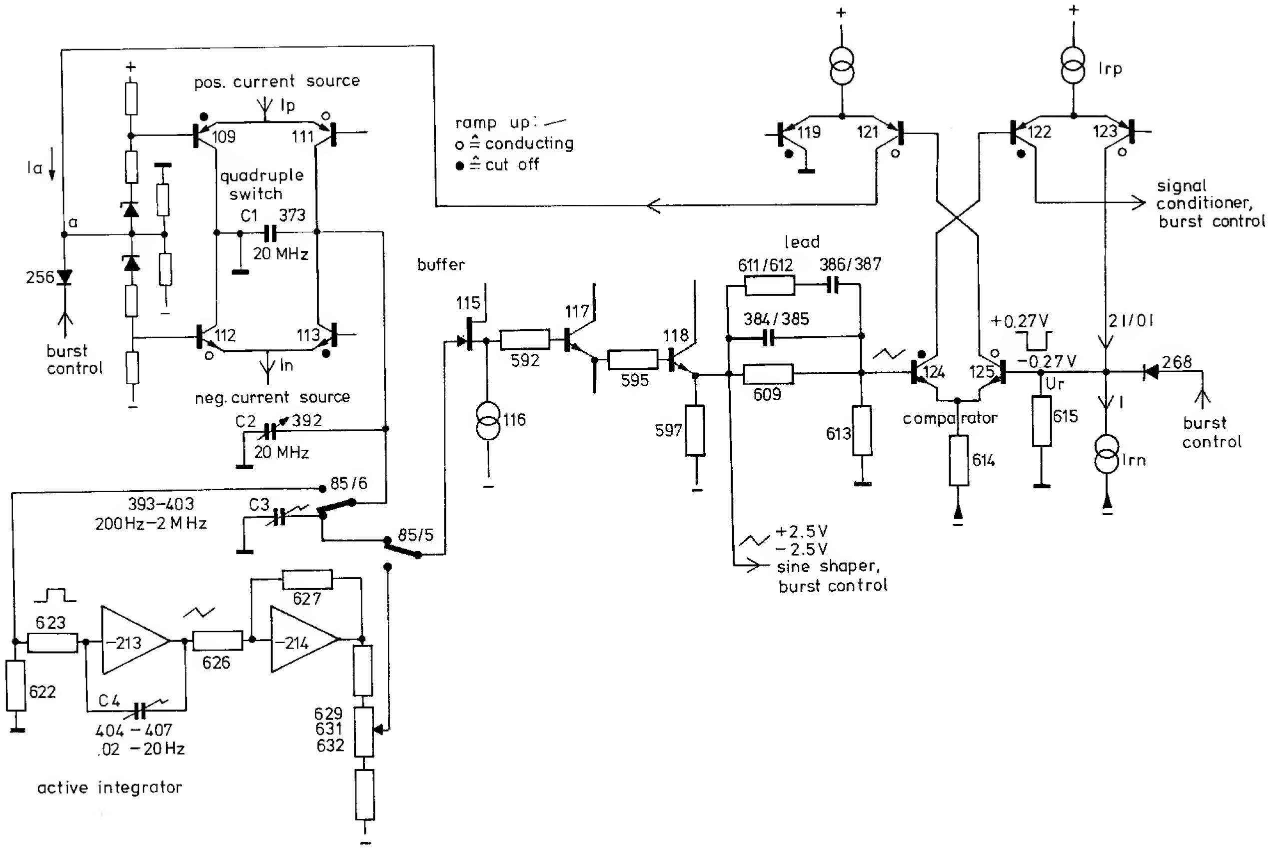


Fig. 4.1 - 3 Main oscillator

On the reference side of the comparator two current sources Irp and Irn generate voltages at resistor 615. Irp has twice the value of Irn. According to the state of transistor 123 either the difference of the two sources results in a +0.27 V reference level or the second source alone generates -0.27 V reference level.

The triangular signal of the oscillator is fed via WAVE FORM switch to the **sine shaper** circuit.
First the peaks of the triangular wave are suppressed by the diodes 311, 312. Then the conversion to sine wave is achieved by a wave form shaping diode-resistor network. Preset controls for minimum distortion are potentiometers 832, 836; 826, 829. The output is routed via a low-pass filter which serves to reduce the harmonic content of the sine wave at the highest frequencies. Preset 844 provides a control adjustment for the amplitude response. The output d.c. offset is set to zero by 840.

The **square wave generator** provides three wave forms, i.e. square wave, positive and negative pulse. The rectangular signal at gate 215 in the signal conditioner controls the square wave generator which comprises two symmetrical current sources 136/137 and 138/139. Positive or negative pulses are performed by switching off one of the two sources. In sine wave, triangle and DC mode the square wave generator is switched off via line 'f'.

The four **buffers** with transistors 128/129, 179/181, 182/183 and 141/142 serve for decoupling the concerning circuitries and for driving the relative low ohmic loads and the various nodes.

4.1.4. **Burst control,** see figs. 4. 1 - 4, 41, 42

The burst function of the main oscillator is controlled by the TTL signal at inputs 216.1.2. When this input is high the oscillator is running free. After a high to low transition of this input the oscillator is completing the last triangular wave cycle on the positive going ramp until the start/stop level is reached.

In NORMAL mode the input control voltage is derived from the TRIG & BURST input socket. Without signal source connected to this input resistor 654 sets 216.1.2 to high; so the main oscillator runs free.

In BURST mode the TTL output voltage of the modulation generator is applied as control voltage. At the low to high transition 216.3 goes low. Therefore 216.10.11. are going high. By this action collector 132 is pulled up to ca. 1.0 V resulting in a reverse voltage at diode 256 in the main oscillator circuitry, thereby releasing the control input of the quadruple switch 109 - 113. Furthermore 216.8 is set to low reversing diode 277/268, thereby releasing comparator 124/125. The main oscillator starts running. When the control voltage at 216.2 is transitioning to low level, pins 216.3.4.12 are going high. By the next positive triggering pulse to 216.5 output 216.6 shortly goes low switching over flip-flop 216.8 - 13. By this action diodes 277/268 are turned on clamping the comparator reference input of the main oscillator to about 1.7 V. Furthermore diodes 275/276 are reversed. When the base voltage of transistor 132 derived from the main oscillator triangular output via buffer stage 128/129 attains the reference voltage at the base of 131, the collector of 132 starts conducting. This current increases until the collector current of 121 is nearly balanced. In this state the control voltage of the quadruple switch at resistor 577 is about 0 V. Now by the regulating function of 131/132 the collector currents of the transistor 113/111 exactly are balanced so that the main oscillator output voltage at emitter 118 is hold at a fixed level. This level can be adjusted by the START PHASE potmeter 605. The described burst function is periodically repeated by the control voltage at 216.2, which is derived from the modulation generator.

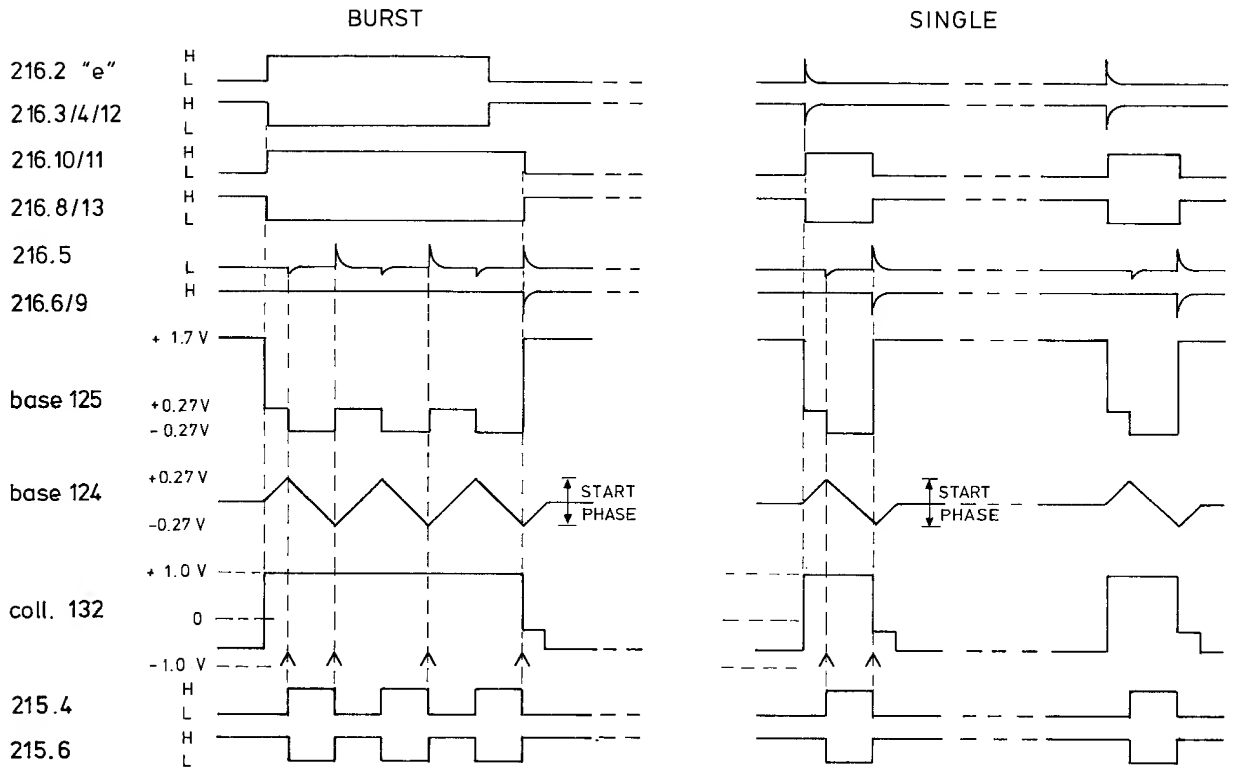


Fig. 4.1 - 4 Timing diagrams for BURST and SINGLE

In SINGLE mode positive trigger pulses are derived from the TTL output signal of the modulation generator at the positive going transitions. This is performed by lead circuit 443, 798. As 216.2 immediately goes low after the trigger pulse, flip-flop 216.8 - 13 is reset by the next trigger pulse to 216.5 derived from the high transition of 215.6. Thus the regulator 131/132 becomes active at the end of one main oscillator cycle. This means that only one oscillator cycle is performed with each trigger pulse to 216.2.

In the 20 MHz range BURST and SINGLE modes are inhibited by transistor 133 which is turned on by 85/1 setting 216.12 to low.

4.1.5. Amplitude modulator

The carrier input voltage of the differential stage 185/186 is derived from the sine shaper. The modulating voltage is applied to the differential stage 189/191. The modulating differential transistor stage consists of the two array transistors 184.1 - 5. The transconductance (mA/V) of this stage is controlled by the collector current of 189 comprising the modulating a.c. portion. In this way the differential output voltage of the modulating stage is the amplitude modulated carrier. Array transistors 184.6 - 11 serve for improving the linearity of the modulator. By trimming potmeter 863 the carrier amplitude can be adjusted. Setting the potmeter 866 defines the AM envelope symmetry. The differential output voltage of the modulator stage is amplified by a differential amplifier comprising transistors 193 - 198. The DC offset of the AM signal is adjusted to 0 V by potmeter 887.

4.1.6. Digital voltmeter circuitry, display

For digital frequency display the internal voltage Uc of the control section (see fig. 4.1 - 2) is routed via resistor 539/541, switch 803 and the instrumentation amplifier (see fig. 4.1 - 5) to the digital voltmeter (DVM) circuitry, where it is converted to digital and indicated by the 7-segment display. The generator output frequency is proportional to the control voltage Uc. The conversion offers the opportunity to indicate high frequencies as well as low frequencies down to 1 mHz immediately. The control voltage Uc varies between 50 mV and 1 V and is amplified by the differential amplifier 401, 402, 403 to Vi = -4 Uc.

For **amplitude display** a d.c. voltage is generated by the tandem section 608/1 of the amplitude potmeter 608 following proportionally the a.c. output amplitude of section 608/2. This d.c. voltage is applied to the **amplitude display conditioner** , the voltage follower 211/1 and routed via switches 84/1, 87/1, 803 and the instrumentation amplifier to the DVM circuitry. Additionally LEDs 354 - 360 are switched off by switch 803 and LED 361 'Vpp' becomes active.
For pulse wave forms the d.c. output voltage of the ampl. display conditioner is halved by resistors 571/572. In addition the output voltage is halved for AM by resistor 564.

The d.c. output voltage of the instrumentation amplifier is converted to digital by the **DVM circuitry** and transferred to the 7-segment display. In this circuitry OP 404/1 generates a stable reference voltage of Vref = +4.0 V. The integrator is represented by OP 404/2 with capacitor 504. This integrator circuit is fed by currents Ii from the instrumentation amplifier and from the chopper output of DVM 405.3. The chopper output of 405 is switching between +Vref and 0 V. This switching function is controlled internally by the DVM 405 depending on the momentary integrator output voltage at pin 1. The resulting integrator output voltage generally is a sawtooth voltage. For small input voltages Vi (frequency or amplitude resp.) the integrator output voltage nearly becomes a symmetrical triangular wave.

In the **DVM** the sample frequency fs is derived from the clock frequency divided by 16. The sample pulses are counted by an internal up/down counter during fixed periods controlled by an internal timer. The up/down counting function depends on the momentary positive or negative going slope of the integrator output voltage. After the up/down counting period the counter state represents the digitalized input voltage. The contents of the counter is transferred to a buffer memory and multiplexed to the display via decoder driver 408. The counter of the DVM 405 is reset and a new conversion cycle is started again.

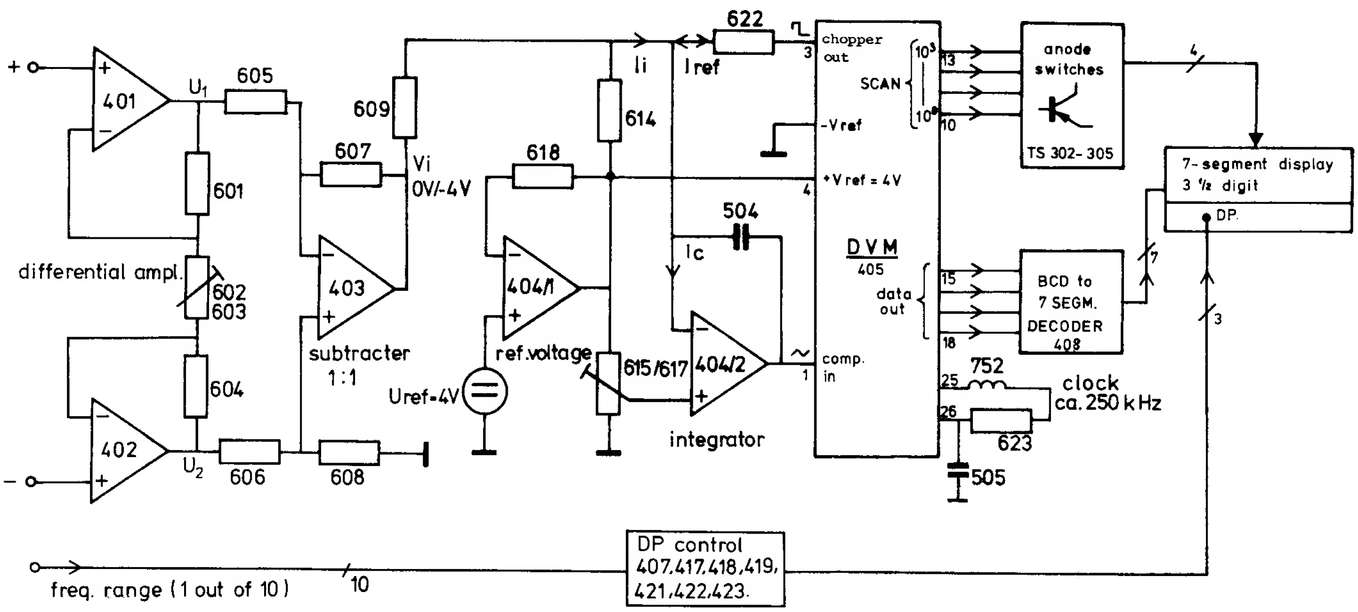


Fig. 4.1 - 5 DVM circuitry, display

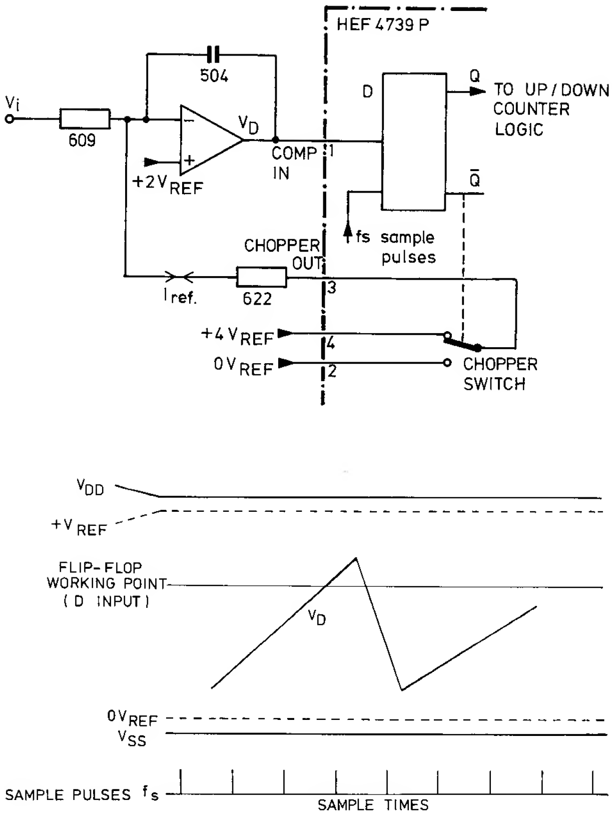


Fig. 4.1 - 6 Principle of delta-pulse mc ⁻ʰulation

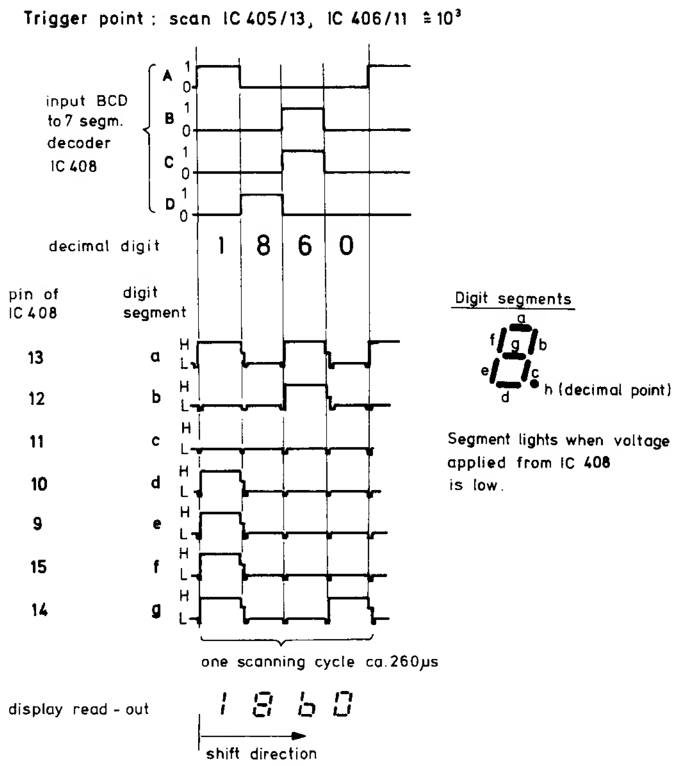


Fig. 4.1 - 7 Timing diagram of display presentation

4.1.7. Digital voltmeter circuit

Details

The ADC HEF 4739 P is based on the principle of delta-pulse modulation. This integrating system ensures good linearity and series mode rejection. In addition, the circuit contains a minimum of critical elements, the accuracy of the ADC being dependent only on the accuracy of the reference voltages. The output of flip-flop FF operates a chopper switch to connect the negative input of the integrator via R to either a positive or a negative reference voltage. The state of the flip-flop depends on the level of the D input at the time of a sample pulse fs. In turn, the level of the D input depends on the state of charge of capacitor C. See fig. 4.1 - 6.

Assume that, at the instant of a pulse fs. the voltage level at D is below the flip-flop working point. This results in a low output from the chopper and a negative reference voltage is connected to R. The input voltage Vi and the reference Vref are both applied to the integrator/comparator. Because Vref is greater than Vi within the scale range, the integrator output voltage increases and is given by:

$$VDc = \frac{1}{RC} (Vi - Vref)\, tc \qquad (1)$$

where tc is the charging time.

At each succeeding sample pulse fs, VD is sampled and when VD exceeds the flip-flop working point the flip-flop changes its state.

The integrator is then connected to the +Vref, its output falls and is given by:

$$VDd = \frac{1}{RC} (Vi + Vref)\, td \qquad (2)$$

where td is the discharge time.

It is seen that providing Vi is greater than 0 the slope resulting from equation (2) is greater than that resulting from equation (1). Since Vref is greater than Vi, these equations show that the sign of the slope changes when the chopper is switched. Thus the integrator output is a sawtooth waveform.

From the equations, it can also be deduced that for a negative input the slopes are reversed; i.e. the positive slope becomes the faster. The digitised feedback limits the charge in the capacitor C so that a charge balance is obtained between the input voltage and the reference voltage. From the compensation method the average value VD (VDc + VDd) will be equal to Vi.

Consequently:

$$Vi = \frac{tc - td}{tc + td}\ Vref \qquad (3)$$

where tc + td = tm (measuring time).

Assuming:

N = total number of pulses fs during tm
n = total number of pulses fs during tc

Then equation (3) can be written as:

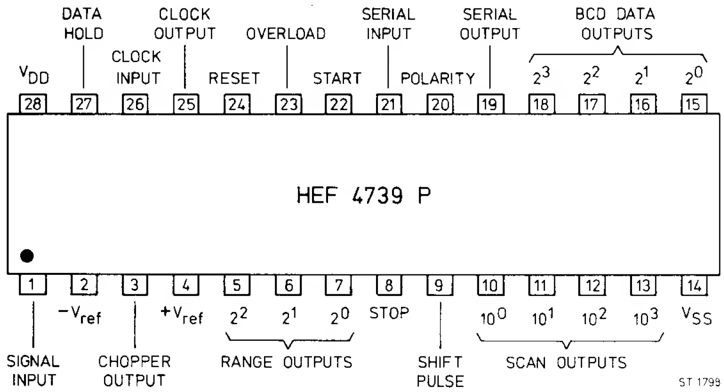
$$Vi = \frac{n - (N-n)}{N}\ Vref \qquad Vi = \frac{2n - N}{N}\ Vref \qquad (4)$$

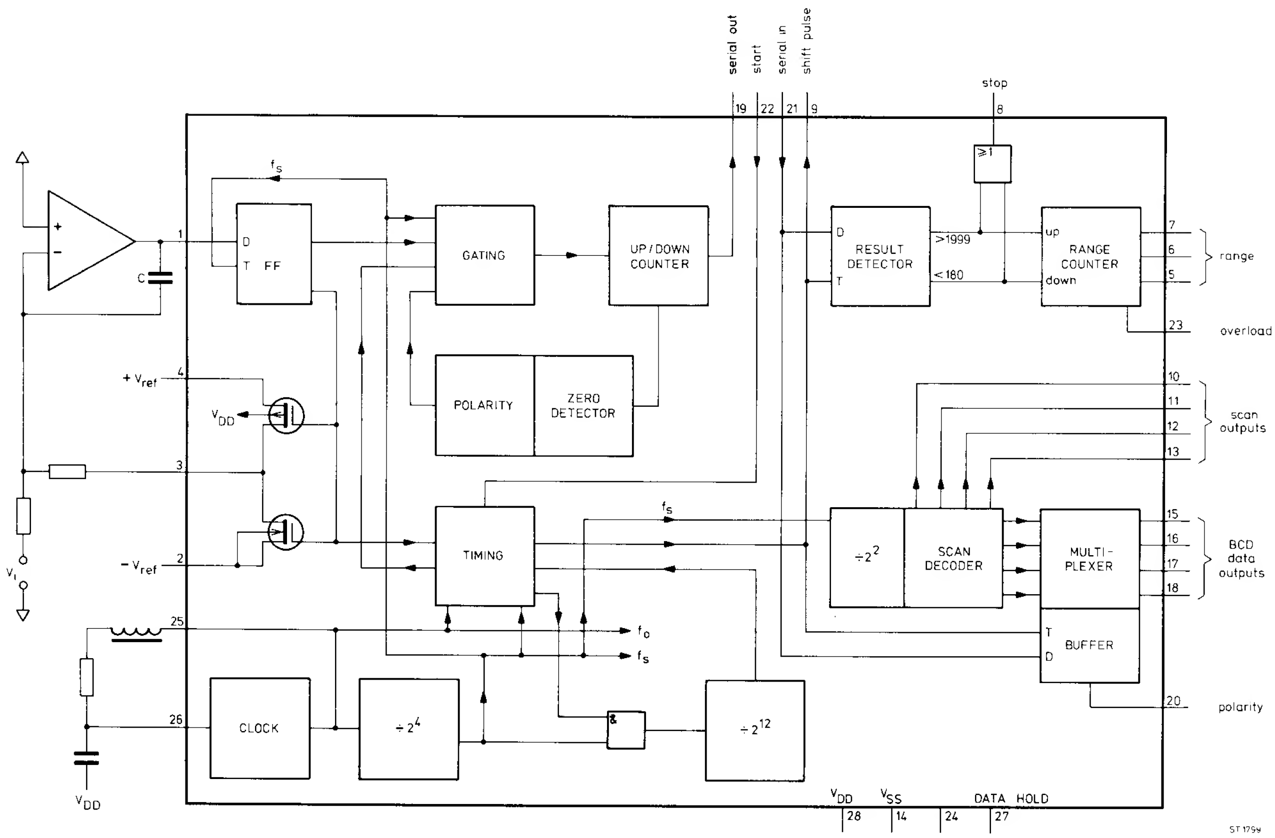
Since an up/down counter is used to count up when + Vref is connected to the integrator, after N sample times the contents of the counter will be 2n – N.

This counter includes polarity and zero detecting sections and counts the absolute value of 2n – N by shifting the counter contents at clock rate through an adder circuit that adds one binary up or down according to the state of Q and the polarity. At the end of the measuring period, the counter content (together with polarity) is serial-shifted out, at clock rate fo, at pin 19 in synchronism with the shift pulses at pin 9. The serial data is organized as follows in NBCD code.

most significant bit = last bit out least significant bit = first bit out

bit no.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
data	POL	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	X
	10^3			10^2				10				1				





In the integrated circuit is N = 4096 and +Vref = +4 V, -Vref = 0 V. The figure shows the internal functions of the block. To obtain a stable display, the contents are divided by two and transferred into a memory, after which the counter is reset. A new measurement can start. Within the circuit block a multiplexer alternately connects each decade of the memory to the decoder driver. At the same time, a pulse is generated to drive the anode switch of the associated 7-segment "LED". The decoded information is then transferred via the decoder driver to the indicator "LED's", the cathodes of which are connected in parallel.

4.1.8. LED and decimal point control

LEDs 357 – 360 indicating the selected frequency range are controlled by switch 85/1 (code: 1 out of 10) and **range control logic** 406, 417, 419 – 421, 424.

Error indication for unallowed combinations of settings (see 3.2.7) is done by LED 362. The error control logic 415 - 417, 424, 449, 451 releases multivibrator 418 and LED 362 starts flashing at a rate of ca. 5 Hz.
Frequency displays < 0100 are monitored by 451, 449, 417. The output at 417.10 is applied to the error control logic activating LED 362 by the multivibrator.

The **decimal point (DP)** of the 3 1/2 digit display 409, 411 – 413 is set by the chosen frequency range by switch 85/1 and DP control logic 407, 417 – 419, 421 – 423.

Check display indication and range LEDs following the table check and adjustments, chapter 4.3.4. seq. 3.4. – 3.19.

Examples for DP- and RANGE-logic

FREQ. RANGE	TERMINAL/LEVEL								
	IC 422	IC 419	IC 423	IC 424	IC 407	IC 412	LED		
20 mHz	.9.10.11.12.13	.1.2.3.11.12.13	.9.10	.5.6.12.13	.3.4	.6	359		
	L L L H H	H L H H H L	H H	H L L H	H L	L	active		
	IC 419	IC 421	IC 424	IC 417	IC 418	IC 423	IC 407	IC 411	LED
2 MHz	.8.9.10	.1.2.8.9	.8.9.12.13	. 5.6	.4.5.6	.14.15	.1.2	.6	360
	H L H	L L H H	L H L H	H L	H L L	H H	H L	L	act.

Check ERROR indication LED 362 following the table check and adjustments chapter 4.3.4. seq. 10.2 - 10.5. and chapter 3.2.7.

Examples for ERROR-logic

MODE	TERMINAL/LEVEL							
SINGLE/ BURST 20 MHz	IC 415	IC 416	IC 417	IC 418	IC 424	LED		
	.8.9.10	.3.4.5.6.10.11.12.13	.8.9	.8.9.10	.1.2	362		
	H H H	L L H H H H L L	L H	L ⎍⎍	⎍⎍	flash		
X–TAL/ AM <0100	IC 451	IC 449	IC 416	IC 415	IC 417	IC 418	IC 424	LED
	.3.4.5.6.10.11.12.13	.11.12.13	.1.2.3.4.5.6.8.9	.4.5.6	.8.9.10.11	.8.9.10	.1.2	362
	L L L H H L L L	L H H	L L H LLHHH	H H H	L H H L	L⎍⎍	⎍⎍L	flash

4.1.9. X–TAL control

The operating principle of the x-tal control is presented in chapter 1.4. In the following part some additional details are given.

The task of the **memory/U2** is to store the displayed frequency number. The input data is derived from the serial output of the DVM 405.19. This data is fed via gates 442 to the input 2 of the shift register 443 serialized by shift register 444. The 16 bits data blocks of the DVM are clocked into the shift registers by the shift pulse at output 9. After each data block a strobe pulse generated by the mono-flop 445 transfers the parallel outputs of the shift registers into the 8 storage registers of 443/444 representing the data memory.

When the **X–TAL LOCK** button is pressed logic H-level is applied to pin 13 of 445 inhibiting the strobe function. Thus the storage register contents are frozen. Furthermore the serial output data of the shift registers 443/444 are repeatedly transfered via gates 441 to the serial input 21 of DVM 405. Thus changing the frequency potmeter setting will have no effect on the display and frequency output.

When pushbutton 803 is set to AMPL inputs 441.6/8/9, 442.1/2/12 and 445.13 are set to logic low and pins 19 and 21 of the DVM are linked via 441. The open-circuit amplitude is displayed. As the strobe function of 445 is inhibited the memory contents are frozen resulting in a fixed output frequency.
The contents of the shift registers is repeatedly shifted from the output 444.9 via 442.8/10/6/4 into the input 443.2, see above. So the memory contents is fixed.

The output data of the memory at 443, pin 12, 13, 14, 7, 6, 5, represent the two significant digits of the frequency number. If both digits are zero (display < 0100) the ERROR LED is activated via 451 and the following gate circuitry.

The **programmable frequency divider** mainly consists of the down counters 452 - 455 which are set to the memory contents at the begin of the down counting period. The task of the frequency divider is to divide the input clock rate applied to the clock input 15 of 452 by a factor N equal to the initial counter content. After N-2 pulses 458.13 becomes high so setting the J-input 10 of 434. The next counter input pulse applied to the clock input 434.13 sets the flip-flop to high. By this action the counters are inhibited via inputs 5. By the next clock pulse the flip-flop is reset and the counters are reloaded to the initial state, because load inputs 1 are set to high via gates 449.

By this operation the output pulse rate of the flip-flop 434 is fc/N, whereby fc is the input clock rate at pin 13. The output pulse width is identical to the input pulse width.

Another functional block controlled by the memory is the **digital-to-analog converter DAC** comprising FETswitches 456/457 and OP459. The 6 most significant bits of the memory contents are converted into analog voltage at output 459.6. The resulting current through 680 is routed to the summing amplifier of the control section thus presetting the main oscillator roughly to the displayed frequency.

The **variable prescaler I** comprises 426, 427, 428. The task of this prescaler is to divide the actual oscillator frequency $f_{act.}$ routed to 426.1 and 427.10 by M = 1, 10 or 100 for the 200 KHz, 2 MHz and 20 MHz sub-ranges respectively. For M = 1 $f_{act.}$ is by-passing 426 and routed via 427 to counter 428.4. As load input 11 is low no frequency division takes place and $f_{act.}$ is outputted at pin 13. For M = 10 the load input is high resulting in an output frequency $f_{act.}/10$. For M = 100 the output frequency $f_{act.}/10$ at 426.12 is routed via 427 to counter 428 and divided additionally by a factor of 10.

The **reference oscillator** comprises a 4 MHz oscillator circuitry with transistors 306/307 and a counter chain with 434 - 436 dividing the oscillator frequency down to 200 Hz. The output frequency of 200 Hz represents the reference frequency in the 20 Hz, 200 Hz, 2 KHz and 20 KHz sub-ranges for the PLL comprising the **phase detector + integrator + VCO** and the programmable freq. divider.
In the frequency ranges 200 KHz, 2 MHz and 20 MHz the reference oscillator output frequency is divided by 2, giving the 100 Hz reference for the **main PLL** comprising the phase detector + integrator, summing amplifier, control section, main oscillator, variable prescaler I and programmable frequency divider.

In the sub-ranges 20 Hz to 20 KHz the PLL comprising 438 and 452 generates an output frequency between 20 KHz - 400 KHz. This frequency is 200 N/Hz, whereby N is the displayed frequency number, decimal point ignored. At the phase detector input 438.14 the 200 Hz oscillator reference is applied. At frequency input 438.3 f_{VCO}/N is fed from the programmable freq. divider, f_{VCO} representing the VCO output frequency at 438.4. Hence $f_{VCO} = 200$ N/Hz. This frequency is routed from 438.4 through switch 439 to the variable prescaler II.

The **variable prescaler II** comprises the frequency dividers 429 - 433, 437 dividing f_{VCO} by P = 20, 200, 2000 or 20 000 depending on the selected frequency sub-ranges. The output frequency $f_{ref.} = f_{VCO}/P$ is routed via switch 439.2 - 4 to the main PLL phase detector. In the 20 KHz sub-range e.g. P = 200 is valid. Hence $f_{ref.} = f_{VCO}/200$.

The **phase detector + integrator/U 1** comprises phase detector 201 and the integrator circuitry OP 202/1. In the sub-ranges 200 kHz, 2 MHz and 20 MHz $f_{ref.}$ = 100 Hz is fed to the input of phase detector 201.1 and $fo/M \cdot N$ to 201.3, with the nominal generator output frequency fo, the division factor M of the variable prescaler I and the division factor N of the programmable frequency divider.
In the phase locked state $fo/M \cdot N$ is 100 Hz.
In the sub-ranges 20 Hz to 20 kHz f_{VCO}/P is applied to 201.1 and fo is applied to 201.3. In the phase locked state, $fo = f_{VCO}/P$ is valid.

The outputs of the phase detector + integrator/U2 and the DAC are combined in the **summing amplifier** which controls the main oscillator frequency fo and phase by the control section.
If the frequency setting is changed the DAC input portion of the summing amplifier effects a fast output frequency response roughly to the nominal frequency fo. Subsequently the integrator output is fine tuning frequency and phase until phase lock is attained.

4.1.10. Power amplifier, see figs. 4.1 - 8, 47

The power amplifier mainly consists of a buffer 311/312, a d.c. low frequency path, high frequency by-pass section, complementary driver stage and complementary output stage. The amplifier with a power consumption of 9 W is supplied by the separate ±20 V voltage regulators 471, 472.

Via buffer 141 and 142, unit 1, the selected signal is applied to the complementary emitter follower 311/312 representing the buffer stage. Behind this buffer the signal is splitted into a low frequency path routed via amplifier 461 ($V \approx 1$), resistor 693 and a high frequency path routed via capacitor 546. Both signals are added at point 'H' and fed to the driver stage 313 - 323. This driver operates as a complementary 4-stage emitter follower driving the complementary common base output stage 324 - 327. The quiescent current of the driver stage and the output stage respectively is about 125 mA. The low frequency portion of the driver output voltage is fed back to the driver input point 'H' via resistors 739/741, OP 461 and resistor 693. The voltage gain of the power amplifier ($V \approx 6.9$) is mainly performed in the output stage and is approximately two times the ratio of the output load (50 Ω) to the effective emitter resistor of each output transistor 326, 327. The DC OFFSET is controlled by potmeter 604 via resistor 686 to the input of 461 and can be set up to ±5 V.

The front panel ATTENUATION pushbuttons 802 permit selection of 3 dB, 6 dB, 10 dB and 20 dB by switching resistors 751 - 767. For 600 Ω output impedance the amplifier output is connected via resistor 698 to the OUTPUT socket.

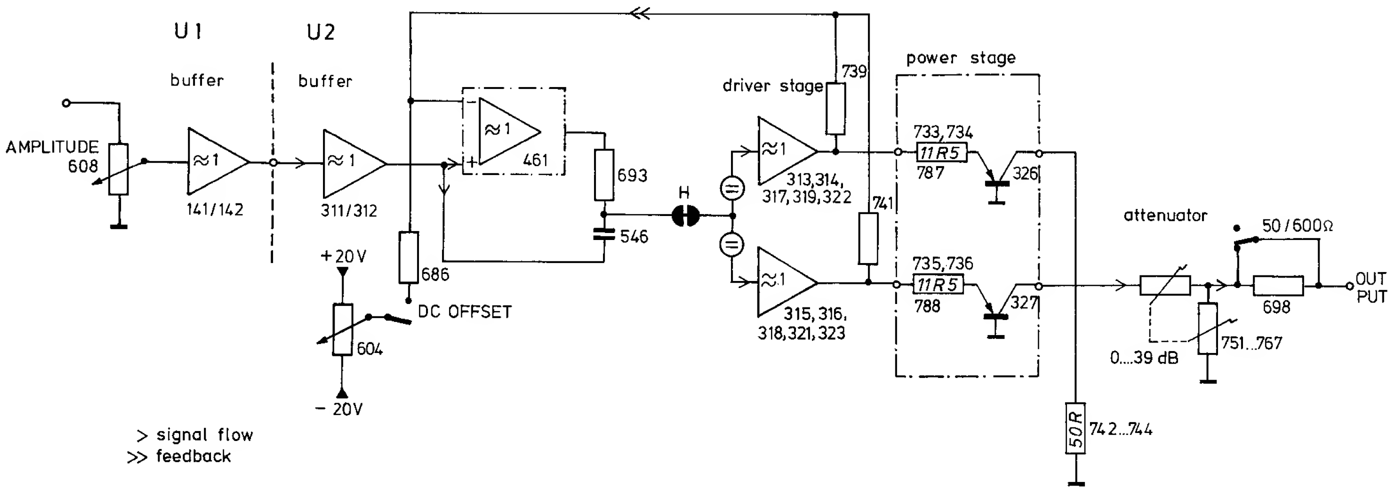


Fig. 4.1 - 8 Power amplifier

4.1.11. Power supply, fan

All five power supplies are realized by means of voltage regulators: a fixed one for +5 V and two adjustable regulators for ±20 V are installed on unit 1. For good electrical and thermal conditions of the power amplifier 2 separate adjustable regulators 471/472 for ±20 V are installed on unit 2. Solder joints A – K on unit 1 and 2 serve for convenient fault finding.

For good heat abduction and stable signal conditions the generator is equipped with a fan, supplied by a secondary voltage (24 Vac) of the mains transformer.

4.2. ACCESS TO PARTS

Before dismantling the instrument, the safety regulations in accordance with para. 2. 2 must be strictly observed.

4.2.1. Cabinet, see 2.5.

4.2.2. Knobs

- Remove the cap from the knob.
- Unscrew the nut and remove the knob.
- When replacing the knob, ensure that the white mark is correctly aligned with the text plate markings.

4.2.3. Text plate

- Remove the cabinet, see 2.5.
- Remove the turn-knobs, see 4.2.2.
- Remove the plastic cover of the mains switch.
- The text plate can now be removed.
  Be careful:
  The textplate is fitted to the frontplate by double sided adhesive tape.

4.2.4. Pushbutton unit
Replacing a pushbutton lever.

The single pushbutton lever can be replaced from the front.

- Push the spring towards the pushbuttons.
- Remove the wire strap and/or lift the plastic reed between the contacts.
- Carefully tear the pushbutton lever out of the pushbutton.

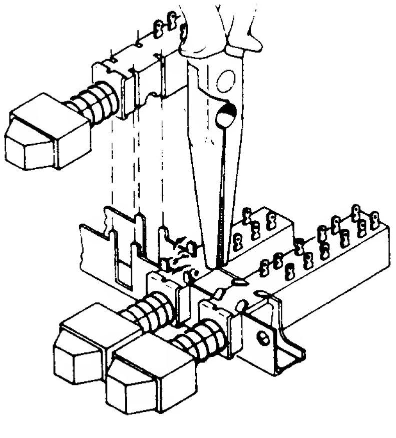
Replacing a switch of the pushbutton unit (see figure below)

- Straigten the 4 retaining lugs of the relevant switches as shown in the figure below.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed circuit board (e.g. with a suction soldering iron).
- Bend the 4 retaining lugs back to their original positions.
- Solder the new switch on to the printed circuit board.

Note: The pushbutton array for the attenuator 802/1-4 must completely be desoldered before you can demount a single pushbutton.

4.2.5. Replacing a rotary switch

For the repair of defective rotary switches on Unit 1 complete switches must be replaced. Single switch-wafers are not available.



4.3. CHECK AND ADJUSTMENT

4.3.1. General

- The limits mentioned in this paragraph are valid only for a newly adjusted instrument and therefore might deviate from the values as stated in paragraph 1.2. "Technical Data".
- Adjustment of the instrument is only permitted after a warm-up time of at least 30 minutes at an ambient temperature of (+23 ±3)^{o} C and when connected to a mains voltage of 220 V ±5 %. For adequate temperature stability during adjustment, the cabinet should be removed only for a short time and so far that the required adjusting element is just accessible.
- If not explicitely stated otherwise, the voltage potentials refer to the relevant contact measured against circuit earth (⊥).
- The following abbreviations are used for setting and measuring instruments:

X	≙ Button pressed	
—	≙ Button not pressed/unlocked	
o	≙ Button only tipped	
rh	≙ extreme right-hand position	
lh	≙ extreme left-hand position	
m	≙ mid-position	
ml	≙ position in the middle between m and lh	
+	≙ LED, lighting	
*	≙ LED, flashing	
o—	≙ outputs, unloaded	
•—	≙ OUTPUT, terminated with 50 Ω, e.g. PM 9585; pushbutton 50 Ω/600 Ω unlocked	
◎	≙ double (coarse/fine) control	
⫪	≙ keep setting concerned	
Vac, Vdc	≙ Digital multimeter for a.c. and d.c. measurements, e.g. 8920A (Fluke)	
OSC	≙ Oscilloscope	e.g. PM 3055
C/T	≙ Counter /Timer	e.g, PM 6665
Fg	≙ Function generator	e.g. PM 5132
DA	≙ Distortion analyzer	e.g. HP 334A
SA	≙ Spectrum analyzer	
50 Ω	≙ 50 Ω terminating resistor	e.g. PM 9585

4.3.2. Preparations

- All trimming potentiometers and capacitors in mid-position; (only for complete new adjustment).
- Solder joints A to K must be closed. To be opened for failure detection only.
- Terminate the OUTPUT by a 50 Ω resistor, if not stated otherwise.

4.3.3. General functional test

- Set the instrument to POWER ON
- Adjust power supply according to seq. 1.1 to 1.5 of the following table
- Actuate all controls for rough functional test of the generator and check all input and output sockets.

4.3.4. Table of checks and adjustments

Seq.	MODE	FREQ RANGE Hz	FREQUENCY START	FREQUENCY STOP	MOD/SWEEP PERIOD s	MOD/SWEEP PERIOD	sweep control HOLD	sweep control RESET	sweep control CONT STD BY	sweep control TRIG	frequency control TUNE LOCK	frequency control AM/FM DEPTH	frequency control START PHASE	frequency control DC OFFSET	WAVE FORM	DUTY CYCLE 603 / DUTY CYCLE	AMPLITUDE 608 / ATTENUAT.	OUTPUT 807 50 Ω / 600 Ω
	84	85	601 /-1 /-2	602 /-1 /-2	86	606	81/1	81/2	81/3	81/4	82/1	608	605	604	87	82/2	802/1-/4	82/3
1.	NORMAL	2 k	m m				–	–	–	–	–	OFF	m	m	∿	m –		–
1.1.	NORMAL																	
1.2.																		
1.3.																		
1.4.																		
1.5.																		
1.6.																		
1.7.																		
2.1.															DC		rh	o—
2.2.		2 k		m m											△			
2.3.																		
2.4.																		
2.5.																		
2.6.																		
2.7.				250 µs														
2.8.				5000 µs														
2.9.		20 k		rh ◎-m														
2.10.															DC △			
3.1.				◎														
3.2.				1 kHz														
3.3.				◎														
3.4.		20 M		2 MHz														
3.5.				20 MHz														
3.6.				◎														
3.7.															∿			
3.8.															⊓⊔			
3.9.		2 M		2 MHz											△			
3.10.		2 M		◎														
3.11.		200 k		200 kHz														
3.12.		200 k		20 kHz														
3.13.		2 k		2 kHz														
3.14.		200		200 Hz														
3.15.		20		500 ms														
3.16.		20		20 Hz														
3.17.		2		2 Hz														
3.18.		.2		2 mHz														
3.19.		.02		20 mHz														
3.20.		20		1 Hz														
3.21.		20 k		m-◎ 10 kHz with coarse control														
3.22.				10 kHz												x;m		
3.23.				10 kHz												lh/rh		

Seq.	outputs TTL	outputs PEN LIFT	MODULATION INT	Inputs AM	Inputs SWEEP/FM	TRIG & BURST	internal measurement FREQ / AMPL	internal measurement display	LED STOP	LED RUN	LED START	LED Vpp	ERROR	measuring point; generator display/ measured value	measuring instrument (see 4.3.1.)	measured value	adjustment, control pos.	remarks
	805	806	804	802	801	803	803/U2		354	355	356	361	362					
1.							–		+									
1.1.														472/U1	Vdc	+20 ±0.05 V	891/U1	power supply
1.2.														473/U1	Vdc	-20 ±0.05 V	894/U1	
1.3.														471/U1	Vdc	+ 5 ±0.25 V		
1.4.														567/U2	Vdc	+20 ±0.05 V	782/U2	
1.5.														568/U2	Vdc	-20 ±0.05 V	785/U2	
1.6.														718/U2	Vdc	+7.8 ±0.05 V	698/U2	if 694/U2 is short-cut
1.7.														719/U2	Vdc	-7.8 ±0.05 V	702/U2	quiescent current adj.
2.1.														0±50mV	Vdc		684/U2	offset adjustment
2.2.														MA1/3-/1	Vac	5 ±0.01 Vpp	599/U4	amplitude
2.3.														MA1/3-/1	Vdc	0 ±10 mV	617/U4	offset
2.4.														MA2/5-/6	Vdc	0 ±1 mV	554/U1	op 208/U1, offset
2.5.														MA2/1-/2	Vdc	0 ±1 mV	556/U1	op 209/U1, offset
2.6.														MA2/3-/4	Vdc	0 ±1 mV	546/U1	op 206/U1, offset
2.7.	o—													250 µs 250 ±0.3 µs	OSC		544 U1	time symmetry, neg. half wave
2.8.	o—													5000µs 5000 ±6 µs	OSC		546 U1	to be adjusted as the pos. half wave
2.9.	o—													20 ±0.2 kHz	C		537/U1	end-of-range frequency
2.10.							x	00.00 Vpp				+					616/U2	offset of int. DVM
3.1.	o—						–	20.00 kHz	+					20.000 kHz	C		603/U2	basic adj. of freq. display
3.2.	o—							01.00 ±1 dig.						1.000 kHz	C		616/U2	if necessary, repeat 2.10 and 3.1
3.3.	o—							f_{STOP} ±1 dig						f_{STOP} ±1 %	C			◎f_{STOP}: 2; 5; 10; 15 kHz
3.4.	o—							02.00 MHz						2 ±0.01 MHz	C		392/U1	FREQ RANGE 20 MHz
3.5.	o—							20.00 MHz						19.8 ±0.1 MHz	C		385/U4	if necessary, repeat 3.4 and 3.5 *
3.6.	o—							f_{STOP}						f_{STOP} ±4 %	C			◎f_{STOP}: 1; 5; 10; 12; 14; 16; 18 MHz
3.7.	o—							20.00 MHz						20 ±0.4 MHz	C			wave form error
3.8.	o—							20.00 MHz						20 ±0.4 MHz	C			
3.9.	o—							2.000 MHz						2.01 ±0.01 MHz	C		403/U1	FREQ RANGE 2 MHz
3.10.	o—							f_{STOP}						f_{STOP} ±3 %	C			◎f_{STOP}: 0.1; 0.2; 0.5; 1.0 MHz
3.11.	o—							200.0 kHz						200 ±0.5 MHz	C		401/U1	if necessary, omit 398
3.12.	o—							020.0 kHz						20 ±0.3 kHz	C			
3.13.	o—							2.000 kHz						2 ±0.02 kHz	C		395/U1	FREQ. RANGE 2 kHz
3.14.	o—							200.0 Hz						200 ±2 Hz	C		393/U1	FREQ. RANGE 200 Hz
3.15.	o—							20.00 Hz						500 500 ± 5 ms	C		625/U1	error < 5 ms ≙ 500 x 0.001
3.16.	o—							20.00 Hz						50 ±0.5 ms	C		632/U1	FREQ RANGE 20 Hz
3.17.	o—							02.00 Hz						500 ±0.5 ms	C		(632/U1)	if necessary, iterate 3.16/3.17
3.18.	o—							200.0 mHz						5 ±0.05 s	C		631/U1	FREQ RANGE .2
3.19.	o—							20.00 mHz						50 ±1.5 s	C		629/U1	FREQ RANGE .02
3.20.	o—							01.00 Hz						1 ± 0.02 s	C			failure at begin of range
3.21.	o—													10 kHz ±10 %	C			◎f_{STOP}-variation ±1 kHz
3.22.	o—													10 kHz ±0.1 kHz	C		549/U1	50 %; duty cycle
3.23.	o—													o	C			10...90 %; 9-11 %/89-91 %

* from LO 04 .. onward 20 MHz range repeat adjustment using added trimmer C487/U1 at 15.8 MHz - 16.2 MHz

Seq.	MODE	FREQ RANGE Hz	FREQUENCY START	FREQUENCY STOP	MOD/SWEEP PERIOD s	MOD/SWEEP PERIOD PERIOD	sweep control HOLD	sweep control RESET	sweep control CONT STD BY	sweep control TRIG	frequency control TUNE LOCK	frequency control AM/FM DEPTH	frequency control START PHASE	frequency control DC OFFSET	WAVE FORM	DUTY CYCLE 603 DUTY CYCLE	AMPLI-TUDE 608 ATTE-NUAT.	OUT-PUT 807 50 Ω 600 Ω
	84	85	601 /-1 /-2	602 /-1 /-2	86	606	81/1	81/2	81/3	81/4	82/1	608	605	604	87	82/2	802/1-/4	82/3
4.1.	SWEEP	20 k	10 kHz						x									
4.2.						x 0.5			x									
4.3.					.1	x1			–									
4.4.					.1	x1												
4.5.	FM				1 m	x.05												
4.6.	FM				1 m	x1												
4.7.					10m	x.05												
4.8.					.1													
4.9.					1													
4.10.					10													
4.11.					100													
4.12.					10m													
4.13.					10m													
4.14.					10m	x1												
4.15.		200 k			10m	x.05						rh					rh	●
5.1.	SWEEP		min	max	10	x1	o	o	x	o		rh					rh	●
5.2.	SWEEP				1	x.05			–									
5.3.	NORMAL	20 k		2.000 kHz														
5.4.	BURST	200 k		200kHz	10 m	x.05							-Π/2...+Π/2				<max	●
5.5.	BURST	2 M		2 MHz	1m	x.05							-Π/2					●
5.6.	SINGLE	2 M		2 MHz	1m	x.05							0°					●
5.7.	NORMAL	200 k		200kHz									0°					●
5.8.	BURST	20 k		20 kHz	1	x1			x	o			0°					●
5.9.	SINGLE	20		20 Hz	1	x1			x	o			0°					●
6.1.	NORMAL	2 k		2 kHz													max	o
6.2.		2k		2 kHz													rh,max	o
6.3.		2 k		2 kHz														o
6.4.		2 M		1 MHz														●
6.5.		20 M		20 MHz														●
6.6.		2 k		2 kHz														●
6.7.																		●
6.8.																		●
6.9.		20 M		20 MHz														●
6.10.		20 k		20 kHz														●
6.11.		20 M		10/15MHz														●
6.12.		20 M		5 MHz														●
6.13.		20 M		16 MHz														●
6.14.		2 M		2 MHz														●

Seq.	outputs TTL	outputs PEN LIFT	MODULATION INT	Inputs AM	Inputs SWEEP/FM	TRIG & BURST	internal measurement FREQ AMPL display	LED indicators STOP	RUN	START	Vpp	ERROR	measuring point; generator display/ measured value	measuring instrument (see 4.3.1.)	measured value	adjustment control pos.	remarks
	805	806	804	802	801	803	803/U2	354	355	356	361	362					bij modulation (rear) → meten sweep period
4.1.	o									+			o 10 kHz ±10 %	C			⊚f_{START}-variation ±1 kHz
4.2.										+			110/U1-107/U1	Vdc	0 ±1 mV	706/U1	f_{START}-offset
4.3.									+				MA3/3-/2	OSC	0 ±20 mV	752/U1	adjustment of neg.
4.4.			o						+				o 0 ±20 mV	OSC		738/U1	peak value
4.5.			o					+					o 20 ±0.2 kHz	C		709/U1	modulation frequency
4.6.			o					+					o 1 ±0.2 kHz	C			modulation frequency
4.7.			o										o 2 ±0.06 kHz	C			
4.8.			o										o 5 ±0.5 ms	C			period time to
4.9.			o										o 50 ±5 ms	C			modulation frequency
4.10.			o										o 500 ±50 ms	C			
4.11.			o										o 5 ±0.5 s	C			
4.12.													MA3/-/2	Vdc	0 ±20 ms	754/U1	
4.13.			o										o k < 0,6 %	DA		769, 772/U1	if k > 0.6 %, correct with 721
4.14.			o										o k < 0,6 %	DA		721/U1	distortion of modul. voltage
4.15.													● 9 ... 11 %	OSC			frequency deviation
5.1.									+	+				OSC			TRIG, RESET, HOLD
5.2.		o							+				o +0,3 ±0,2 V/+20 V	Vdc			sweep/fly-back
5.3.	o				+2.00V			+					o 10.00 ±0.80 kHz	C			SWEEP/FM INPUT
5.4.														OSC	100 % / 30 %	647/U1	symmetry of START PHASE range
5.5.														OSC			ringing at burst-end < 30 %
5.6.													● per. single sign.	OSC			per. generation of single signals
5.7.													● per. burst sign.	OSC			20 kHz-TTLsignal: per. burst signals
5.8.						20kHz							● burst signal	OSC			burst trigger
5.9.													single signal	OSC			single shot trigger
6.1.													● 20 ±1 Vpp	Vac			
6.2.													o 10 ±0.1 Vpp	OSC	o (±10)±0.1Vpp	674; 681	output amplitude
6.3.													o 0 ±0.2 V	OSC			pulse: zero level
6.4.													● < 17 ns	OSC	< 3 %		rise time, fall time, ringing
6.5.													●	OSC		657/U1	time symmetry
6.6.													● k < 0.2 %	DA	(step 1)	832, 836/U1	if necessary, pre-set: 826 lh, 629 rh (k of carrier frequency); Distortion adjustment
6.7.													● k→min	DA	(step 2)	826, 829/U1	fine adj. with all controls
6.8.													● 0 ±50 mV	Vdc		840	offset for sinus
6.9.													● 18 Vpp - 1 dB	SA		844/U1	-1 dB, related to amplitude at 2 kHz
6.10.													● ±1 %	Vac			related to amplitude at 2 kHz
6.11.													● ±5 %	SA			or 6 MHz
6.12.													● ≤-32 dB	SA			all harmonics
6.13.													● ≤-28 dB	SA			at least . . . dB
6.14.													● ≤-37dB	SA			below fundamental

Seq.	MODE	FREQ RANGE Hz	FREQUENCY START	FREQUENCY STOP	MOD/SWEEP PERIOD s	PERIOD	sweep control HOLD	sweep control RESET	sweep control CONT STD BY	sweep control TRIG	frequency control TUNE LOCK	frequency control AM/FM DEPTH	frequency control START PHASE	DC OFFSET	WAVE FORM	DUTY CYCLE 603 / DUTY DYCLE	outputs AMPLITUDE 608 / ATTENUAT.	outputs OUTPUT 807 / 50 Ω 600 Ω	TTL	PEN LIFT	MODULATION INT	Inputs AM	Inputs SWEEP/FM	TRIG & BURST	internal measurement FREQ AMPL	display	LED indicators STOP	RUN	START	Vpp	ERROR	measuring point; generator display/ measured value	measuring instrument (see 4.3.1.)	measured value	adjustment, control pos.	remarks
	84	85	601 /-1 /-2	602 /-1 /-2	86	606	81/1	81/2	81/3	81/4	82/1	607	605	604	87	82/2	802/1-/4	82/3	805	806	804	802	801	803	803/ U2		354	355	356	361	362					
6.15.	NORMAL	2 k		2 kHz											~		x	●									+					● 3;6;10;20 dB ±0.2dB	Vac			one button pushed at a time
7.1.	↓	↓		↓											↓		l.h –	o							x	02.00 Vpp				+		o 707,1 mVrms	Vac		562/U1	if necessary, to be repeated until display
7.2.																	rh –	o							x	20.00 Vpp				+		o 7,071 Vrms	Vac		558/U1	<±1 digit of output voltage
7.3.																	5Vpp	o							x	05.00 Vpp				+		o 1,767 ±0.177 Vrms	Vac			
																	10Vpp	o							x	10.00 Vpp				+		o 3,536 ±0.177 Vrms	Vac			
																	15Vpp	o							x	15.00 Vpp				+		o 5,303 ±0,177 Vrms	Vac			
7.4.																	*	●							–		+					● 3.5 ±0.07 Vrms	Vac			output impedance (* set open circuit
7.5.														lh/rh	DC		*	x●									+					● 0.54 ±0.01 Vrms	Vac			voltage to 7 Vrms)
																	max	–o									+					o -4.5 ... -5.5 to +4.5 ... +5.5 V	Vdc			offset range: -5 ... +5 V
8.1.	AM	2 k		2 kHz								OFF			~		↓	o							x	0,5xA ±3% NORM				+		o 0.5xA NORM ±1 %	DM		863/U1	AM ampl. = 0.5 of normal ampl.
8.2.	↓	20 k		20 kHz	10 m	x1						50 %			↓			o							–							o	OSC		866/U1	modulator symmetry
8.3.		20 k		20 kHz								OFF						o														o ±20 mV	DM		887/U1	modulator offset
8.4.		20 M		1...20MHz								OFF					max	●														● +1··· –2 dB	OSC/SA			amplitude response, related to 2 kHz
8.5.		2 k		2 kHz	10 m	x1						<max					max	●														● ≥ 100 %	OSC			modulation deviation
		20 M		20 MHz																												≥ 100 %	OSC			
8.6.		20 k		20 kHz								OFF			↓		max	●				2.0Vpp										● approx. 50 %	OSC			modulation ext.
9.1.	X–TAL	2 M		2 MHz							x								o							2.000 MHz						o 2.000000 MHz	C		511/U2	X–TAL clock
9.2.	↓	2 M		0.1 MHz							x				~		max	●								0,1 00 MHz							● OSC		502/U1	jitter to minimum
9.3.		2 k		1.590kHz							–								o							1.590 kHz						o 1.590 kHz	C			
9.4.		20 M		01.00MHz															o							01.00 MHz						o 1.000 MHz	C			X–TAL function in 20 MHz range
				15.90MHz															o							15.90 MHz						o 15.90 MHz	C			
				20.00MHz															o							20.00 MHz						o 20.00 MHz	C			
9.5.	↓	20		1.0 Hz															o													o 1000 ms ±0.1 %	C			setting time < 30 s
10.1	SWEEP				1m or 10m																										*					
10.2	BURST	20 M																													*					ERROR indication, flashing
10.3.	SINGLE	20 M																													*					
10.4.	X–TAL	2																													*					
	X–TAL AM	.2																													*					
		.02																													*					
		20...20M		◎																						< 0100					*					
10.5.		20 M														x															*					

4.4. SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

4.4.1. General directives

- Take care that creepage distance and clearances have not been reduced
- Before soldering, wires:
  should be bent through the holes of solder tags, or wrapped round the tag in the form of an open U, or, wiring ridigity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

4.4.2. Safety components

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 4.5.1.

4.4.3. Checking the protective earth connection

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5 Ω. During measurement the mains cable should be moved. Resistance variations indicate a defect.

4.4.4. Checking the insulation resistance

Measure the insulation resistance at U = 500 Vdc between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulation resistance shall not be less than 2 MΩ.

Note:
2 MΩ is a minimum requirement at 40 °C and 95 % relative humidity. Under normal conditions the insulation resistance should be much higher (10 to 20 MΩ).

4.5. SPARE PARTS

4.5.1. General

Standard Parts

Electrical and mechanical parts replacement can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE:
Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special Parts

In addition to the standard electronic components, some special components are used:

- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument, marked with 'S' in the parts list.

ATTENTION:
Both type of components may only be replaced by components obtained through your local Philips organisation.

4.5.2. Static sensitive components

This instrument contains electrical components that are susceptible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

4.5.3. Handling MOS devices

Though all our MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental over-voltages. In storing and handling them, the following precautions are recommended.

CAUTION:
Testing or handling and mounting call for special attention to personal safety. Personnel handling MOS devices should normally be connected to ground via a resistor.

4.5.4. Mechanical parts, miscellaneous, parts not on units

Item	Figure	Quantity	Order number	Description	
1		1	5322 447 40049	cover, brown	
2		4	5322 462 10222	foot (bottom side), brown	
3		2	5322 520 34164	bearing bush	
4		2	5322 530 84075	spring	
5		2	5322 528 34101	rachet	
6		2	5322 532 51481	ring for handle, brown	
7		2	5322 498 54048	arm for handle	
8		1	5322 498 54051	carrying handle	
9		2	5322 414 30043	knob, brown	
10		4	5322 462 44176	foot (rear side)	
11		1	5322 502 14164	coin-slot screw (rear side)	
12		1	4822 530 70124	locking washer (rear side)	
13		7	5322 532 51309	insulating bush for BNC socket	
15	34	1	5322 321 14048	mains cable 1850	*S
16	34	1	5322 401 14275	cable clamp	*S
17	34	1	5322 325 54067	lead through	*S
18	34	1	5322 325 60119	pull relief	*S
19		4	5322 462 34125	print holder	
100		1	4822 253 30016	fuse 400 mAT	*S
–		1	4822 253 30019	fuse 800 mAT	*S
20	31	8	5322 414 70016	cap for knob 601–608, brown	
21	31	4	5322 414 70015	cap for knob 84–87, brown	
22		12	5322 414 20033	knob for pushbutton, brown	
23		6	5322 414 30053	knob pos. 603–608, brown	
24		2	5322 414 30041	knob 601/602, 10 mm Ø, brown	
25		4	5322 414 30071	knob pos. 84–87, brown	
26		2	5322 414 30037	knob 601/602, 14 mm Ø, brown	
27		5	5322 267 10004	BNC connector	
802, 805	32 a	2	5322 267 10173	BNC connector (long)	
28		–	5322 390 24013	silicon paste DC 340	
80		1	5322 146 20672	mains transformer	*S
29	37	1	5322 361 10238	fan	*S
809	37	1	5322 121 44364	line filter FKE 250	*S
30		1	5322 450 60217	window	
31	39, 44	5	5322 255 40263	heat sink, unit 1/2	
32	44	4	5322 255 40264	heat sink, unit 2	
33	40	1	5322 530 80231	S-clip, unit 4	
34		11	5322 526 10015	damping bead 3.5 x 3 mm	
35		7	5322 526 10212	damping bead 3.5 x 7.5 mm	

*S = Safety component, see chapter 4.5.1.

Item	Fig.	Quantity	Order number	Description	
36		1	5322 255 44047	IC-socket, 28-pole	
37		4	5322 255 44122	IC-socket, 14-pole	
83	31	1	5322 276 14433	mains switch	*S
81/1/2	31	2	5322 276 10959	pushbutton switch U1	
81/4	31	1	5322 276 10959	pushbutton switch U1	
81/3	31	1	5322 276 10961	pushbutton switch U1	
82/2	31	1	5322 276 10961	pushbutton switch U1	
82/1/3	31	2	5322 276 14221	pushbutton switch U1	
802	31	1	5322 276 40292	pushbutton switch U2	
803	31	1	5322 276 10962	pushbutton switch U2	
84	31	1	5322 273 80247	rotary switch	
85	31	1	5322 273 80248	rotary switch	
86	31	1	5322 273 50201	rotary switch	
87	31	1	5322 273 60127	rotary switch	
601/602	31	2	5322 101 20669	carbon potm. 4k7+4k7	
603	31	1	5322 103 64043	potmeter 5k0/5	
604	31	1	5322 101 64029	carbon potm. 22 kOhm lin.	
605	31	1	4822 101 20441	carbon potm. 10 kOhm lin.	
606	31	1	4822 101 20416	carbon potm. 4k7 lin.	
607	31	1	5322 101 40101	carbon potm. 10 kOhm lin.	
608	31	1	5322 102 10183	carbon potm. 1k0+1k0 Ohm	
372	37	1	4822 122 30103	capacitor 22 N/63 V cer.plate	
450	37	1	5322 122 30108	capacitor 100 N/50 V	
487 – 492	37	6	5322 122 30108	capacitor 100 N/50 V	
486	37	1	4822 121 40176	capacitor 1 µF/100 V	
527/528	37	2	5322 116 50511	resistor 48.7 Ohm MR 25	
559	37	1	5322 116 55571	resistor 14.0kOhm MR 25	
561	37	1	5322 116 50926	resistor 40.2 Ohm MR 25	
640	37	1	4822 116 51268	resistor 100 kOhm MR 25	
691	37	1	5322 116 54459	resistor 75 Ohm MR 25	

S = Safety component, see chapter 4.5.1.

4.5.5. Electrical parts

UNIT 1

Some parts are listed in chapter 4.5.4.
All metal film resistors not listed
see end of this list

TRANSISTORS/U1

101-103	4822 130 44197	BC558B
104-106	4822 130 40937	BC548B
107	4822 130 44104	BC328
128	4822 130 44568	BC557B
129	4822 130 40959	BC547B
131	4822 130 40937	BC548B
132	4822 130 40902	BF240
133,134	4822 130 40937	BC548B
135,136	5322 130 40417	BSX20
137,141	5322 130 44127	2N2894A
138	5322 130 44201	2N4035
139,142	5322 130 40417	BSX20
144,145	4822 130 44568	BC557B
146	5322 130 44509	BFQ16
147-149	4822 130 40959	BC547B
151,152	4822 130 40937	BC548B
153,154	4822 130 44197	BC558B
155-157	4822 130 40937	BC548B
158,159	4822 130 44568	BC557B
161,178	4822 130 40959	BC547B
162,171	4822 130 44197	BC558B
163-165	4822 130 40937	BC548B
166	4822 130 41095	BC337-16
172,173	4822 130 40937	BC548B
174,176	4822 130 44197	BC558B
175	4822 130 40937	BC548B
177	4822 130 44568	BC557B
179,182	4822 130 44197	BC558B
181,183	4822 130 40937	BC548B
184	4822 209 80365	CA3046 (TBA331) trans.array
185-187	4822 130 40902	BF240
188-192	4822 130 40959	BC547B
193,195	4822 130 44237	BF450
194,196	4822 130 40902	BF240
197	4822 130 40959	BC547B
198	5322 130 44201	2N4035

INTEGRATED CIRCUITS/U1

201	5322 209 85821	MC4044L
202,211	5322 209 85512	MC1458N
203	4822 209 80617	UA741CN
204,205	5322 209 86056	LM308AN
206,208	5322 209 71647	MC1456 P1
207,214	5322 209 86056	LM308AN
209,219	5322 209 71647	MC1456 P1
213	5322 209 86355	LF355N
215	5322 209 84167	SN74SOON
216	5322 209 84823	N74LSOON
218	5322 209 85571	NE531N

221	5322	209	84778	OQ011
222	5322	209	14104	HEF4066BP
223	5322	209	85201	SN74LS132N
225	5322	209	85512	MC1458N
226	5322	209	84841	UA7805UC
227	5322	209	85565	78GCU1
228	5322	209	86349	79GCU1

DIODES/U1

251,252	4822	130	34233	BZX79-B5V1
254	4822	130	34297	BZX79-B10
255	4822	130	34048	BZX75-C2V8
271,272	4822	130	34233	BZX79-B5V1
273,274	4822	130	34297	BZX79-B10
275,277	4822	130	34049	BZX75-C2V1
276	5322	130	34321	1N4151
278	4822	130	30229	AAZ15
279	4822	130	31248	BZY46-C2V0
281	5322	130	34413	BZX61-C16
282,283	5322	130	34321	1N4151
284	5322	130	34413	BZX61-C16
285,286	4822	130	34197	BZX79-B12
291	4822	130	34233	BZX79-B5V1
292	4822	130	30229	AAZ15
293-295	4822	130	34233	BZX79-B5V1
296,299	5322	130	34321	1N4151
297	4822	130	34173	BZX79-B5V6
298	4822	130	34281	BZX79-B15
301	4822	130	34233	BZX79-B5V1
302,303	4822	130	34488	BZX79-B11
304-325	5322	130	34321	1N4151
326,328	4822	130	34297	BZX79-B10
327	5322	130	34321	1N4151
331,332	4822	130	34047	BZX75-C1V4
335-337	5322	130	32031	SKB2/08/L5A, RECTIFIER

CAPACITORS/U1

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
350	4822 124 40434	22UF		35V	ELECTROLYTIC
351	4822 124 20678	47UF		10V	ELECTROLYTIC
352	5322 121 40227	1.5UF	10	100V	POLYESTER FOIL
353	5322 121 40324	15NF	10	400V	" "
354	4822 121 40231	100NF	10	100V	" "
355,356	5322 124 10016	68UF		20V	TANTAL
357	4822 121 40257	330NF	10	100V	POLYESTER FOIL
358	5322 121 40283	3.3UF	10	100V	" "
359,361	4822 122 30043	10NF	-20+80	100V	CERAMIC PLATE
360	4822 124 40178	100UF		16V	ELECTROLYTIC
362,363	4822 122 30034	470PF	2	100V	CERAMIC PLATE
364	4822 122 30103	22NF	-20+80	63V	" "
365	4822 122 30128	4.7NF	10	100V	" "
366,368	4822 122 31221	1.5NF	10	100V	" "
369,371	4822 122 30043	10NF	-20+80	100V	" "
370,373	4822 122 31221	1.5NF	10	100V	" "

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
377,391	4822 124 20698	22UF		25V	ELECTROLYTIC
392	4822 125 50131	1.8-18PF		250V	TRIMMER
394	5322 121 50829	4.7UF	5	100V	POLYESTER FOIL
396	5322 121 41533	470NF	5	100V	" "
397	5322 121 50832	49.9NF	1	63V	" "
398	4822 122 31521 may be omitted	56PF	2	100V	CERAMIC PLATE
399	5322 121 50831	4.87NF	1	63V	POLYESTER FOIL
401	5322 125 50183	11-120PF		150V	TRIMMER
402	4822 122 31348	390PF	5	100V	CERAMIC PLATE
403	4822 125 50017	5.5-65PF		100V	TRIMMER
404	5322 121 40224	4.7UF	10	100V	POLYESTER FOIL
405	5322 121 40175	470NF	10	100V	" "
406	5322 121 54108	47NF	1	63V	" "
407	4822 121 50539	4.7NF	1	63V	" "
408	4822 122 30034	470PF	2	100V	CERAMIC PLATE
409,411	4822 122 30043	10NF	-10+80	100V	" "
412,419	4822 124 20698	22UF		25V	ELECTROLYTIC
413	4822 122 31045	4.7PF	0.25PF	100V	CERAMIC PLATE
415,418	4822 122 30103	22NF	-20+80	63V	" "
416	4822 124 20678	47UF		10V	ELECTROLYTIC
417	4822 122 31072	47PF	2	100V	CERAMIC PLATE
420	4822 122 31067	33PF	2	100V	" "
421,425	4822 122 30103	22NF	-20+80	63V	" "
422,423	4822 122 30034	470PF	2	100V	" "
424	4822 124 20698	22UF		25V	ELECTROLYTIC
426,427	4822 122 30043	10NF	-20+80	100V	CERAMIC PLATE
428	4822 122 30027	1NF	10	100V	" "
431	4822 121 50566	1NF	1	250V	POLYESTER FOIL
432	4822 121 50088	3.6NF	1	63V	" "
433	5322 121 54108	47NF	1	63V	" "
434	5322 121 40175	470NF	10	100V	" "
435	5322 121 40224	4.7UF	10	100V	" "
436	4822 122 30034	470PF	2	100V	CERAMIC PLATE
437-439	4822 122 30027	1NF	10	100V	" "
441-443	4822 122 31413	150PF	2	100V	" "
444,451	4822 122 30103	22NF	-20+80	63V	" "
446	4822 122 30097	15PF	2	100V	" "
452,453	5322 121 40308	22NF	10	400V	POLYESTER FOIL
454	4822 122 31045	4.7PF	0.25PF	100V	CERAMIC PLATE
455-458	4822 122 30043	10NF	-10+80	100V	" "
461	4822 122 30128	4.7NF	10	100V	" "
462,463	4822 124 20698	22UF		25V	ELECTROLYTIC
471	4822 124 20722	1UF		63V	"
472	5322 121 40323	100NF	10	100V	POLYESTER FOIL
473	4822 124 20722	1UF		63V	ELECTROLYTIC
474-476	4822 121 40232	220NF	10	100V	POLYESTER FOIL
477	4822 124 20779	2200UF		16V	ELECTROLYTIC
478,479	4822 124 20798	3300UF		40V	"
481-483	4822 121 40232	220NF	10	100V	POLYESTER FOIL
485	4822 121 40252	6.8UF	10	100V	" "

COILS/U1

491,492	5322 158 10538	COIL 220MUH
493	5322 158 10343	COIL,CHOKE 1.5MUH
494-496	5322 158 10132	COIL,FXC-BROAD.BAND

RESISTORS/U1

ITEM	ORDERING NUMBER	OHM	TOL(%)	TYPE	REMARKS
502	4822 100 10036	4K7		LIN	POTM.TRIMMING
503	5322 116 55535	1M	1	MR25	METAL FILM
529	5322 116 55034	10K5	0.1	MR25	" "
531,532	5322 116 54155	100K	0.1	MR25	" "
533	5322 116 55034	10K5	0.1	MR25	" "
536	5322 116 51418	887E	0.1	MR25	" "
537,544	5322 101 14051	220E		LIN	POTM.TRIMMING
538	5322 116 50747	1K	0.1	MR25	METAL FILM
543	5322 116 51418	887E	0.1	MR25	" "
545,557	5322 116 50746	100E	0.1	MR25	" "
546,554	4822 100 10079	47K		LIN	POTM.TRIMMING
549	5322 101 14047	470E		LIN	" "
555	5322 116 50747	1K	0.1	MR25	METAL FILM
556	4822 100 10079	47K		LIN	POTM.TRIMMING
558	5322 101 14008	2K2		LIN	" "
562,681	5322 101 14011	100E		LIN	" "
564	5322 116 54888	20K	0.1%	MR25	METAL FILM
571,572	5322 116 50748	10K	0.1%	MR25	METAL FILM
625	5322 101 14069	22K		LIN	POTM.TRIMMING
629-632	4822 100 10036	4K7		LIN	" "
634	5322 111 90137	10K			RESISTOR-NETW.
647	4822 100 10075	100E		LIN	POTM.TRIMMING
657	4822 100 10019	220E		LIN	" "
674	5322 101 14011	100E		LIN	" "
675,679	4822 116 51105	470E	5	PR37	METAL FILM
704,751	5322 116 55458	442K	1	MR25	" "
706,738	4822 100 10037	1K		LIN	POTM.TRIMMING
709,769	4822 100 10029	2K2		LIN	" "
714	5322 116 54188	1M	1	MR30	METAL FILM
721	4822 100 10035	10K		LIN	POTM.TRIMMING
752	4822 100 10079	47K		LIN	" "
754,772	4822 100 10037	1K		LIN	" "
826,829	4822 100 10038	470E		LIN	" "
836	5322 101 14051	220E		LIN	" "
840,894	4822 100 10019	220E		LIN	" "
844	4822 100 10035	10K		LIN	" "
863,866	4822 100 10037	1K		LIN	" "
887	4822 100 10079	47K		LIN	" "
891	4822 100 10038	470E		LIN	" "
896	5322 116 54188	1M	1	MR30	METAL FILM

TRANSISTORS/U2

301	5322	130	44452	BFQ11,FET
302-305	4822	130	40988	BC328-25
306,307	4822	130	44196	BC548C
308	4822	130	44197	BC558B
311,313	4822	130	44568	BC557B
312,316	4822	130	40959	BC547B
314	4822	130	44237	BF450
315	4822	130	40902	BF240
317,324	4822	130	44197	BC558B
318,325	4822	130	40937	BC548B
319,323	5322	130	40468	2N2905A
321	5322	130	44034	2N2219A
322	5322	130	44015	BFW16A
326	4822	130	40824	BD140
327	4822	130	40823	BD137

DIODES/U2

351,352	4822	130	34297	BZX79-B10	
353	5322	130	34397	BZX93	see item 612, page 4 – 30
353	5322	130	34405	1N823	
363	4822	130	34174	BZX79-B4V7	
364-372	4822	130	34233	BZX79-B5V1	

INTEGRATED CIRCUITS/U2

401	5322	209	86355	LF355N
402	5322	209	71647	MC1456 P1
403	4822	209	80617	UA741CN
404	5322	209	85512	MC1458N
405	5322	209	85327	HEF4739VP
406	5322	209	84994	SN74LS05N
407	5322	209	84035	N7416N
408	5322	209	86282	N7447AN
415	5322	209	14054	HEF4081BP
416,421	5322	209	14067	HEF4075BP
417	4822	209	10185	HEF4069UBP
418	5322	209	14045	HEF4001BP
419,425	5322	209	14053	HEF4071BP
420	5322	209	85703	N74LS01A
422	5322	209	14074	HEF4072BP
423	5322	209	14068	HEF4050BP
424	5322	209	84994	SN74LS05N
426	5322	209	85255	N74LS90N
427	5322	209	84823	N74LS00N
428	5322	209	85329	N74LS192N
429-433	5322	209	14184	HEF40192BP
434,437	5322	209	14055	HEF4027BP
435,436	5322	209	14064	HEF4518BP
438	5322	209	14126	HEF4046BP
441,442	5322	209	14046	HEF4011BP
443,444	5322	209	14485	HEF4094BP
445	5322	209	14191	HEF4528BP
449	5322	209	14046	HEF4011BP
451	5322	209	14052	HEF4025BP
452-455	5322	209	14075	HEF4510BP
456,457	5322	209	14104	HEF4066BP

458	5322 209 14234	HEF4078BP
459	4822 209 80617	UA741CN
461	5322 209 85571	NE531N
471	5322 209 85565	78GCU1
472	5322 209 86349	79GCU1

CAPACITORS/U2

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
501,502	4822 122 31056	12PF	2	100V	CERAMIC PLATE
503	4822 122 30103	22NF	-20+80	63V	" "
504	4822 121 50566	1F	1	250V	POLYESTER FOIL
505	4822 122 30095	270PF	10	100V	CERAMIC PLATE
506,516	4822 121 40232	220NF	10	100V	POLYESTER FOIL
510	4822 124 20679	100UF		10V	ELECTROLYTIC
511	5322 125 54083	2.5-27PF		100V	TRIMMER
512	5322 122 31682	18PF	2	100V	CERAMIC PLATE
513	4822 122 31173	220PF	10	100V	" "
514	5322 122 34201	120PF	2	100V	" "
515	4822 122 30027	1NF	10	100V	" "
517	4822 122 30103	22NF	-20+80	63V	" "
518	4822 124 20678	47UF		10V	ELECTROLYTIC
519	4822 122 31243	82PF	2	100V	CERAMIC PLATE
520	4822 124 20679	100UF		10V	ELECTROLYTIC
521	5322 121 40233	680NF	10	100V	POLYESTER FOIL
522	5322 121 44232	22NF	10	400V	" "
523	4822 122 30128	4.7NF	10	100V	CERAMIC PLATE
524-527	4822 122 30043	10NF	-20+80	100V	" "
530	4822 124 20945	33UF		10V	ELECTROLYTIC
540	4822 122 30114	2.2NF	10	100V	CERAMIC PLATE
541,542	4822 122 30043	10NF	-20+80	100V	" "
543	4822 122 31212	0.47PF	0.25PF	500V	" "
544,545	4822 122 30103	22NF	-20+80	63V	" "
546	5322 121 44232	22NF	10	400V	POLYESTER FOIL
547,548	4822 122 30103	22NF	-20+80	63V	CERAMIC PLATE
549,551	4822 122 30128	4.7NF	10	100V	" "
550	4822 122 30114	2.2NF	10	100V	" "
552-557	4822 122 30103	22NF	-20+80	63V	" "
558,559	4822 121 40232	220NF	10	100V	POLYESTER FOIL
561,562	4822 122 30027	1NF	10	100V	CERAMIC PLATE
563,564	4822 122 30103	22NF	-20+80	63V	" "
565,566	4822 122 31504	100PF	2	100V	" "
567,568	4822 124 20698	22UF		25V	ELECTROLYTIC
569	4822 121 40257	330NF	10	100V	POLYESTER FOIL
570,580	4822 124 20944	1UF		25V	ELECTROLYTIC
571	4822 124 40244	2.2UF		63V	"

RESISTORS/U2

ITEM	ORDERING NUMBER	OHM	TOL(%)	TYPE	REMARKS
601	5322 116 54285	19K6	0.1	MR25	METAL FILM
603	5322 101 14008	2K2		LIN	POTM.TRIMMING
604-608	5322 116 54285	19K6	0.1	MR25	METAL FILM
609,614	5322 116 54892	200K	0.1	MR30	" "
612	5322 116 55033	1K05	0.1	MR25	" " for BZX93
612	5322 116 55278	909E	1	MR25	" " for 1N823

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ITEM	ORDERING NUMBER	OHM	TOL(%)	TYPE	REMARKS
613	5322 116 54292	1K69	0.1	MR25	" "
615,617	5322 116 55036	12K1	0.1	MR25	" "
616	4822 100 10037	1K		LIN	POTM.TRIMMING
622	5322 116 54227	100K	0.1	MR30	METAL FILM
624	4822 110 72192	1.5M	5	VR25	HIGH VOLT.RESIST.
625	5322 116 55258	511K	1	MR25	METAL FILM
661	4822 110 72196	2M2	5	VR25	HIGH VOLT.RESIST.
673	5322 116 55283	402K	0.5	MR25	METAL FILM
684	5322 101 14069	22K		LIN	POTM.TRIMMING
685	5322 116 55371	383K	0.5	MR25	METAL FILM
698,702	4822 100 10038	470E		LIN	POTM.TRIMMING
718,719	5322 116 55509	130E	5	PR37	POWER METAL FILM
733-736	5322 116 51457	31E6	1	MR52	METAL FILM
742-744	5322 116 53959	150E	1	MR52	" "
782	4822 100 10038	470E		LIN	POTM.TRIMMING
785	4822 100 10019	220E		LIN	" "

COILS/U2

657	5322 158 10243	COIL,100MUH
770	5322 158 10271	COIL,FXC-BROADBAND
780	5322 158 10276	COIL,4.7MUH
790	5322 158 10278	COIL,1.0MH

CRYSTAL/U2

801	4822 242 70325	CRYSTAL 4.0000 MHZ

DIODES/U3

354-362	4822 130 80692	PLED – P314N
366	5322 130 34321	1N4151

DISPLAY/U3

409-413	5322 130 34389	HP5082-7730,DISPLAY

TRANSISTORS/U4

108	4822 130 44197	BC558B
109,111	5322 130 44127	2N2894A
112	5322 130 40417	BSX20
113	5322 130 40542	BFX89
114	4822 130 40937	BC548B
115	4822 130 41024	BF245B
116,117	4822 130 40902	BF240
118	5322 130 44034	2N2219A
118	5322 130 44015	BFW16A onwards series LO 13/...
119-123	5322 130 44127	2N2894A
124,125	5322 130 40542	Q BFX89
126	4822 130 40902	BF240
127	4822 130 44237	BF450

DIODES/U4

256,268	5322 130 32239	BA481
257-259	4822 130 34233	BZX79-B5V1
260	4822 130 30861	BZX79-B7V5
261	4822 130 34233	BZX79-B5V1
262	4822 130 34195	BZX79-C13
263	5322 130 34397	BZX90
264	5322 130 34321	1N4151
265-267	4822 130 34048	BZX75-C2V8
269	4822 130 34047	BZX75-C1V4

CAPACITORS/U4

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
372,374	4822 122 30128	4.7N	10	100	CERAMIC PLATE
373,384	4822 122 31061	18PF	2	100	" "
375*	4822 122 31221	1.5N	10	100	" "
376-383	4822 122 30099	3.3N	10	100	" "
385	5322 125 50184	1.2-5.5PF		100	TRIMMER
386	4822 122 30094	220PF	10	100	CERAMIC PLATE
387	4822 122 31056	12PF	2	100	" "
388,389	4822 122 30099	3.3N	10	100	" "

RESISTORS/U4

ITEM	ORDERING NUMBER	OHM	TOL(%)	TYPE	REMARKS
593*	5322 116 51461	2.61E	1	MR25	METAL FILM
599	5322 101 14051	220E		LIN	POTM.TRIMMING
617	5322 101 10294	1.0K		LIN	" "

* omitted from series LO 013... onwards

LACQUERED METAL FILM RESISTORS MR25

style	resistance range	tol.	series	temperature coefficient	limiting voltage(r.m.s.)	**service code number:** *** = 4822 116 .....** **# = 5322 116 .....**
MR25	4,99 Ω – 1M Ω	± 1%	E96	50ppm/°C*	250V	(last 5 digits see table)

* for resistance values lower than 49,9 Ω;100ppm/℃.

4.99	# 50568
5.11	* 52999
5.23	* 53019
5.36	* 53001
5.49	* 53002
5.62	* 53003
5.76	# 54413
5.90	* 53004
6.04	* 53005
6.19	# 80148
6.34	* 53006
6.49	* 53007
6.65	* 53008
6.81	* 53009
6.98	* 53011
7.15	* 53012
7.32	* 53013
7.50	* 53014
7.68	* 53015
7.87	* 53016
8.06	* 53017
8.25	* 53018
8.45	# 54421
8.66	# 51051
8.87	# 54101
9.09	# 53516
9.31	# 54422
9.53	# 54258
9.76	# 54423
10	* 52891
10.2	* 52896
10.5	* 52901
10.7	* 52905
11	* 52909
11.3	* 52915
11.5	* 52948
11.8	* 52954
12.1	* 52959
12.4	* 53029
12.7	* 53031
13	* 53032
13.3	* 53033
13.7	* 53034
14	* 53035
14.3	* 53036
14.7	* 53037
15	* 51221
15.4	# 55573
15.8	* 53038
16.2	* 53039
16.5	# 54109
16.9	# 53654

17.4	# 54432
17.8	# 50418
18.2	# 54083
18.7	# 50895
19.1	-----
19.6	# 53721
20	* 53797
20.5	# 53635
21	# 54433
21.5	# 53426
22.1	# 50983
22.6	# 53637
23.2	# 54434
23.7	# 53606
24.3	# 54435
24.9	# 53608
25.5	# 54436
26.1	# 53723
26.7	# 54067
27.4	# 50493
28	# 55588
28.7	# 60478
29.4	# 54084
30.1	# 53638
30.9	# 54437
31.6	# 54964
32.4	# 55421
33.2	# 53612
34	-----
34.8	# 53725
35.7	# 54439
36.5	# 80116
37.4	# 54158
38.3	# 50954
39.2	# 53544
40.2	# 53493
41.2	# 54108
42.2	# 53515
43.2	# 50519
44.2	# 50818
45.3	# 50795
46.4	# 53248
47.5	# 80483
48.7	# 53643
49.9	# 54441
51.1	# 53213
52.3	# 54443
53.6	# 54444
54.9	# 54445

56.2	# 53644
57.6	# 54447
59	# 54448
60.4	# 53657
61.9	# 53645
63.4	# 54375
64.9	# 53647
66.5	# 54454
68.1	# 53264
69.8	# 53621
71.5	# 53528
73.2	# 54458
75	# 53339
76.8	# 50494
78.7	# 53561
80.6	# 54461
82.5	* 52814
84.5	# 54463
86.6	# 54464
88.7	# 54465
90.9	# 53626
93.1	# 54467
95.3	# 53563
97.6	# 54468
100	# 55549
102	* 52895
105	* 52897
107	* 52902
110	* 52906
113	* 52911
115	* 52916
118	* 52949
121	* 52955
124	* 52961
127	# 54479
130	# 53548
133	# 53424
137	# 54483
140	# 55568
143	# 54485
147	# 53569
150	* 52846
154	# 53653
158	# 55418
162	# 53523
165	# 54488
169	# 54489
174	# 55461

178	# 53572
182	# 54493
187	# 80144
191	# 54495
196	# 55273
200	# 53731
205	# 55365
210	# 54036
215	# 55274
221	* 51223
226	# 53242
232	# 54498
237	# 53259
243	# 53607
249	# 53573
255	# 80296
261	# 53549
267	# 80479
274	# 53427
280	# 55586
287	# 53221
294	# 54507
301	# 55366
309	# 55464
316	# 53514
324	# 53556
332	* 51226
340	# 54514
348	# 53591
357	# 50603
365	# 53575
374	# 54517
383	# 55368
392	* 51228
402	# 53639
412	# 54521
422	# 53592
432	* 51229
442	# 53641
453	# 80121
464	# 53232
475	# 53249
487	# 55451
499	# 53545
511	* 51282
523	# 80122
536	# 53335
549	# 53618
562	* 51231

576	# 54527
590	* 53584
604	# 54528
619	* 51232
634	# 54531
649	# 53646
665	# 54533
681	* 51233
698	# 54037
715	# 53622
732	# 54535
750	* 51234
768	# 55427
787	# 53648
806	# 80128
825	# 53541
845	# 54542
866	# 53474
887	# 55574
909	# 55278
931	# 54546
953	# 80229
976	# 80307
1K	* 51235
1K02	* 52893
1K05	* 52898
1K07	* 52903
1K1	* 51236
1K13	* 52912
1K15	* 52121
1K18	* 52951
1K21	* 52956
1K24	* 52962
1K27	# 53321
1K3	* 51238
1K33	# 55422
1K37	# 55446
1K4	# 55569
1K43	# 55572
1K47	# 53185
1K5	* 51239
1K54	# 53571
1K58	# 80106
1K62	# 55359
1K65	# 54566
1K69	# 53491
1K74	# 50629
1K78	# 53208

service code number: *** = 4822 116 .....** **# = 5322 116 .....**

1K82	# 54568
1K87	# 52123
1K91	# 54569
1K96	# 53237
2K	# 53605
2K05	# 53634
2K1	* 51244
2K15	# 50767
2K21	* 51245
2K26	# 53243
2K32	# 80108
2K37	# 53536
2K43	# 80109
2K49	# 53574
2K55	# 54577
2K61	# 53327
2K67	# 54578
2K74	* 53055
2K8	# 55587
2K87	# 55279
2K94	# 51396
3K01	* 51246
3K09	* 53186
3K16	* 53021
3K24	# 53611
3K32	* 51247
3K4	# 54584
3K48	# 55367
3K57	# 54586
3K65	# 53245
3K74	# 54588
3K83	* 53079
3K92	* 51249
4K02	# 55448
4K12	# 54593
4K22	# 53246
4K32	# 53559
4K42	# 53578
4K53	# 80489
4K64	# 53212
4K75	# 53614
4K87	# 55445
4K99	# 53616
5K11	# 53494
5K23	# 80303
5K36	# 53546
5K49	# 54598
5K62	* 51281
5K76	# 80304
5K9	# 53251
6K04	# 54601
6K19	# 55426
6K34	# 53619
6K49	# 53579
6K65	# 80124
6K81	* 51252
6K98	# 54605
7K15	# 80125
7K32	# 55372
7K5	# 55324
7K68	# 55373
7K87	# 53529
8K06	# 55428
8K25	# 51498
8K45	# 80334
8K66	# 53625
8K87	# 54614
9K09	* 51284
9K31	# 54616
9K53	# 53562
9K76	# 54618
10K	* 51253
10K2	* 52894
10K5	* 52899
10K7	# 55357
11K	* 52907
11K3	* 52913
11K5	# 55358
11K8	* 52952
12K1	* 52957
12K4	# 54626
12K7	# 53488
13K	* 53082
13K3	# 55276
13K7	# 54628
14K	# 55571
14K3	# 54631
14K7	* 53531
15K	* 51255
15K4	# 55459
15K8	# 80292
16K2	# 55361
16K5	# 80293
16K9	# 53322
17K4	# 55447
17K8	# 53235
18K2	# 80475
18K7	# 55362
19K1	# 54639
19K6	# 53258
20K	# 53732
20K5	# 55419
21K	# 54644
21K5	# 50451
22K1	* 51257
22K6	# 55291
23K2	# 54645
23K7	# 53537
24K3	# 80478
24K9	# 80265
25K5	# 54649
26K1	# 53261
26K7	* 53532
27K4	* 53078
28K	# 80297
28K7	# 55462
29K4	# 53655
30K1	# 53209
30K9	# 80298
31K6	# 53262
32K4	# 54658
33K2	* 51259
34K	# 54659
34K8	# 53429
35K7	# 80299
36K5	# 53557
37K4	# 51397
38K3	# 55369
39K2	* 51262
40K2	# 53613
41K2	# 55423
42K2	# 53431
43K2	* 51263
44K2	# 55449
45K3	# 54669
46K4	# 53314
47K5	# 80482
48K7	# 53615
49K9	# 50674
51K1	* 53121
52K3	# 54673
53K6	* 53202
54K9	# 54675
56K2	* 51264
57K6	# 54677
59K	* 80036
60K4	# 80305
61K9	* 51265
63K4	# 54681
64K9	# 50514
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68K1	* 51266
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71K5	# 53623
73K2	# 50666
75K	* 51267
76K8	# 80126
78K7	# 53649
80K6	# 54688
82K5	# 55374
84K5	# 54691
86K6	# 80357
88K7	# 55452
90K9	# 53582
93K1	* 80424
95K3	# 80291
97K6	# 55591
100K	* 51268
102K	* 52895
105K	# 55356
107K	* 52904
110K	* 52844
113K	* 52914
115K	* 52947
118K	* 52953
121K	* 52958
124K	# 54705
127K	# 54706
130K	* 53118
133K	* 53344
137K	# 54628
140K	# 54259
143K	# 54711
147K	# 53256
150K	* 51269
154K	# 53604
158K	# 54715
162K	# 53535
165K	# 54717
169K	# 53345
174K	# 54719
178K	# 53555
182K	# 54722
187K	* 53796
191K	# 55363
196K	# 55364
200K	* 52848
205K	# 55387
210K	# 54208
215K	# 53425
221K	* 51272
226K	# 53636
232K	# 54731
237K	# 80145
243K	# 54733
249K	# 80295
255K	# 54735
261K	# 53609
267K	# 80481
274K	# 54738
280K	# 54739
287K	# 55463
294K	# 54742
301K	# 53328
316K	* 53058
332K	# 53331
348K	# 80115
365K	# 55641
374K	# 55457
383K	# 53576
402K	# 55283
412K	# 55424
422K	# 53577
442K	# 80146
464K	# 55207
475K	* 51275
499K	# 55468
511K	# 53334
536K	# 80147
562K	# 53656
590K	# 53336
619K	* 53359
649K	# 55331
681K	# 55284
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806K	# 51369
825K	# 51398
866K	# 51395
909K	# 55533
953K	# 80197
1MAO	# 55535

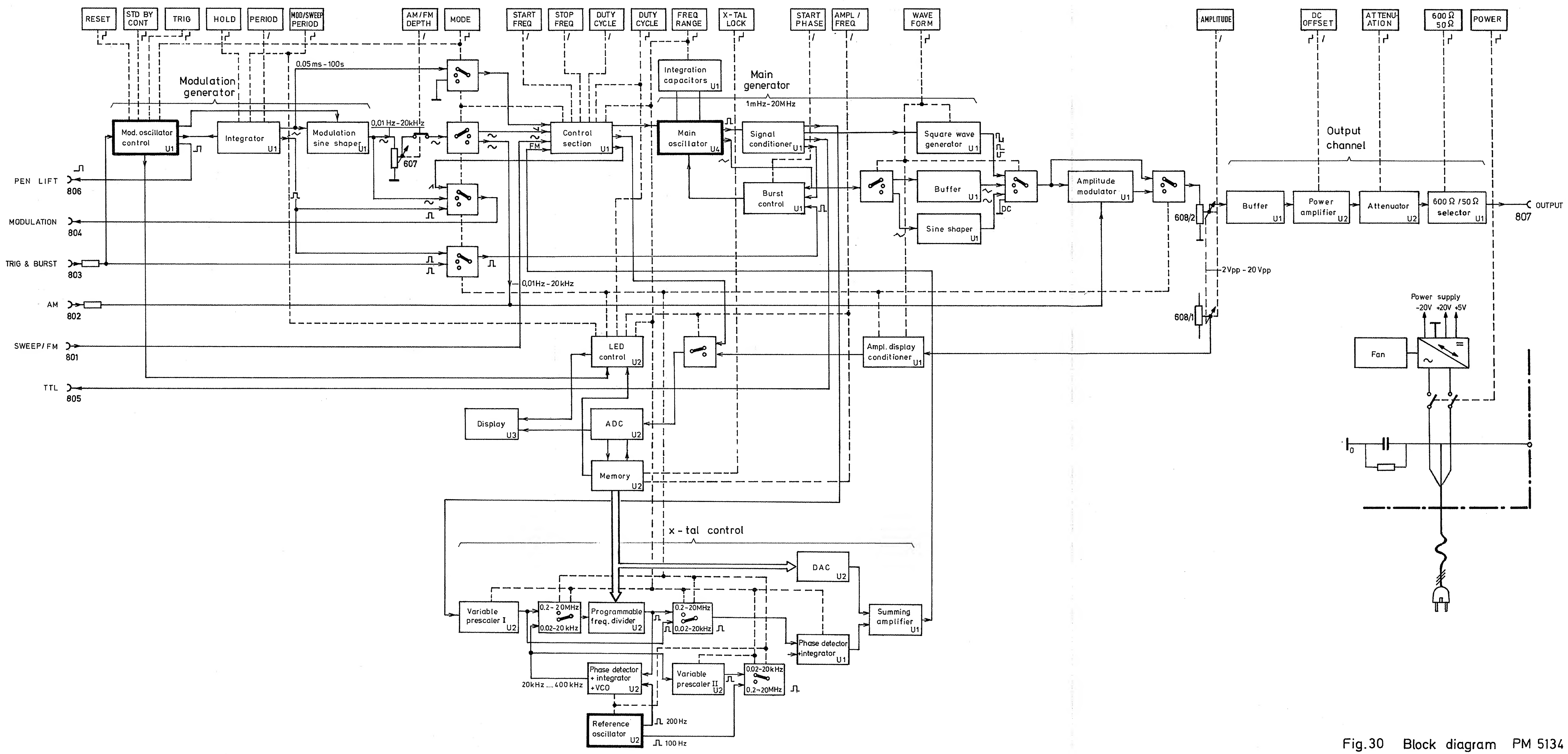


Fig.30 Block diagram PM 5134

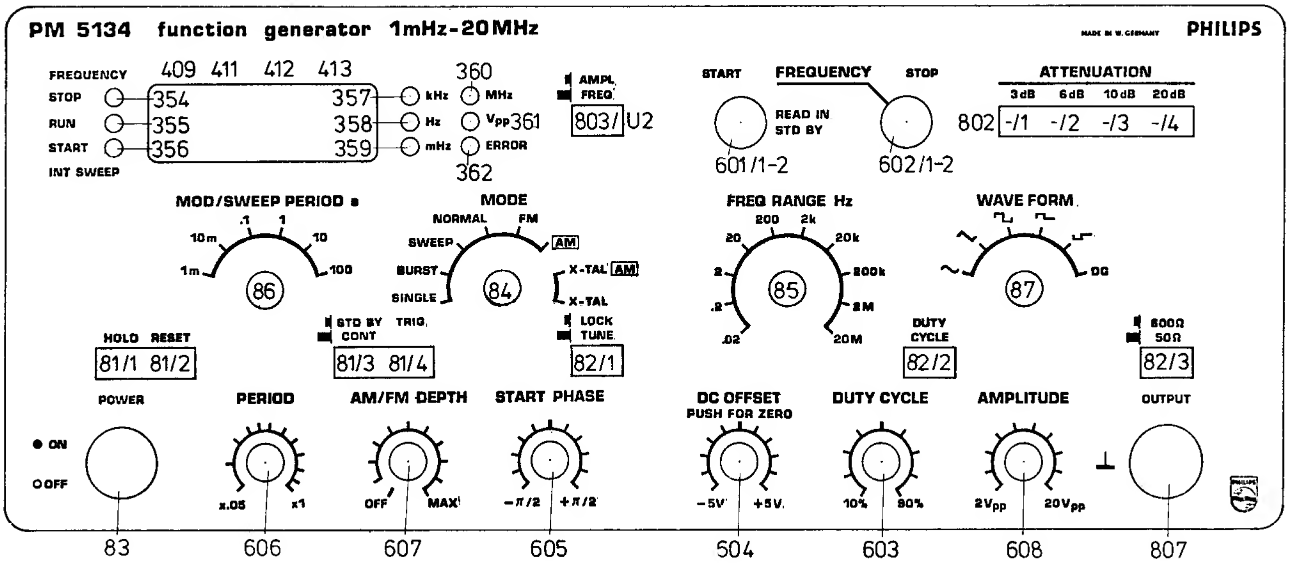


Fig. 31 Front view

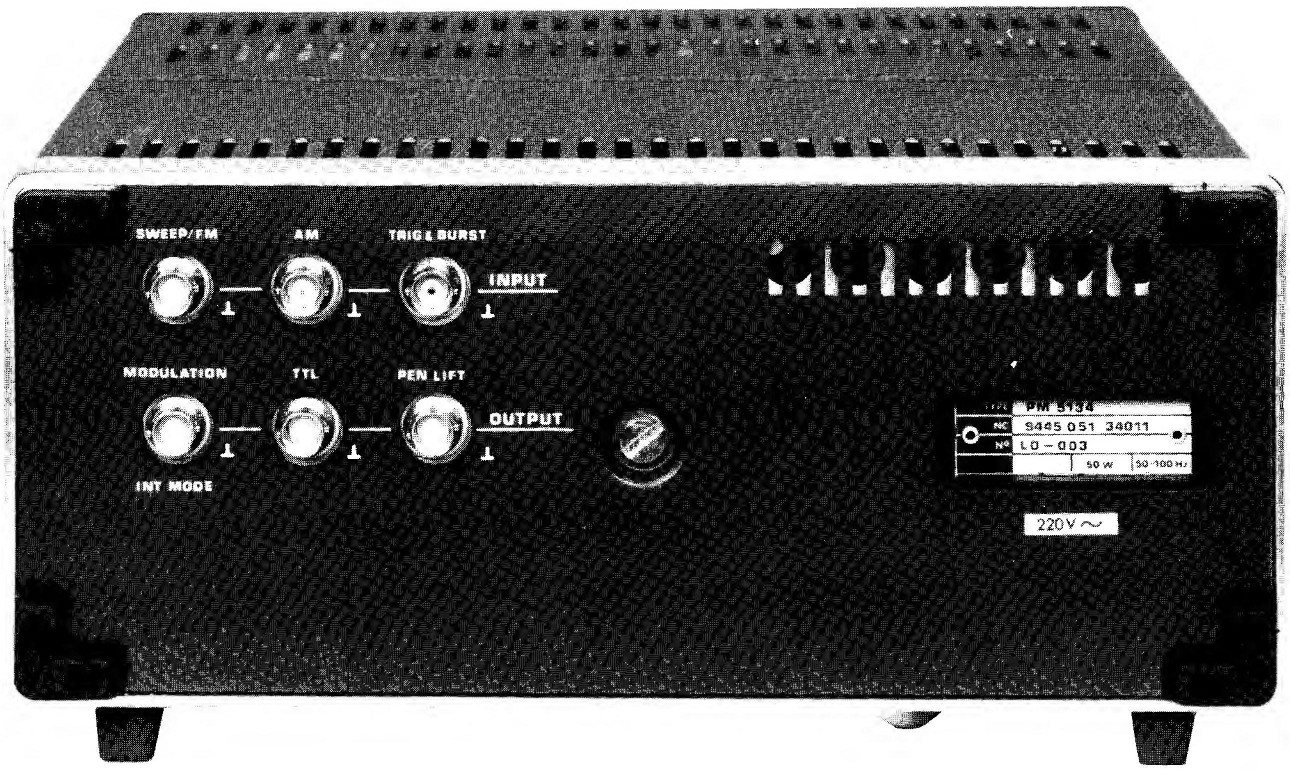
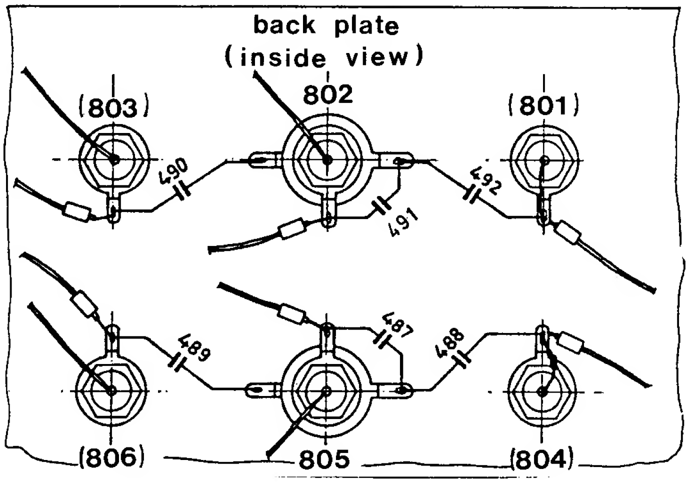


Fig. 32 Rear view



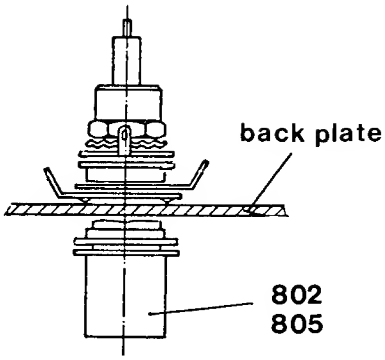


Fig. 32a Back plate (internal view)

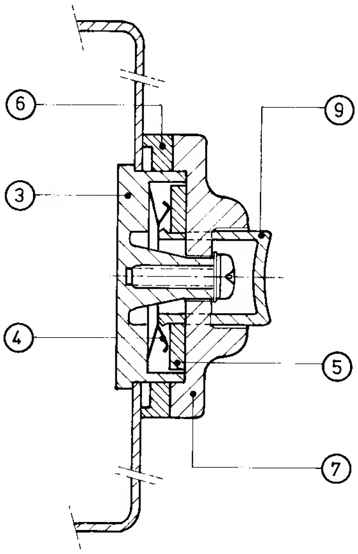


Fig. 33 Handle: spare parts

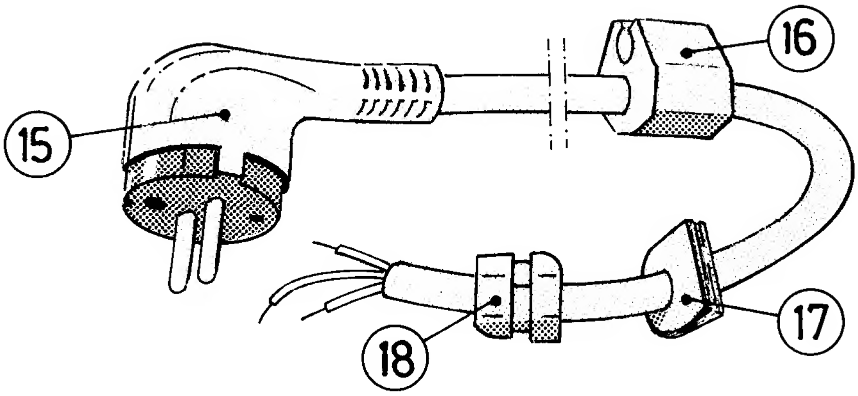


Fig. 34 Mains cable: spare parts

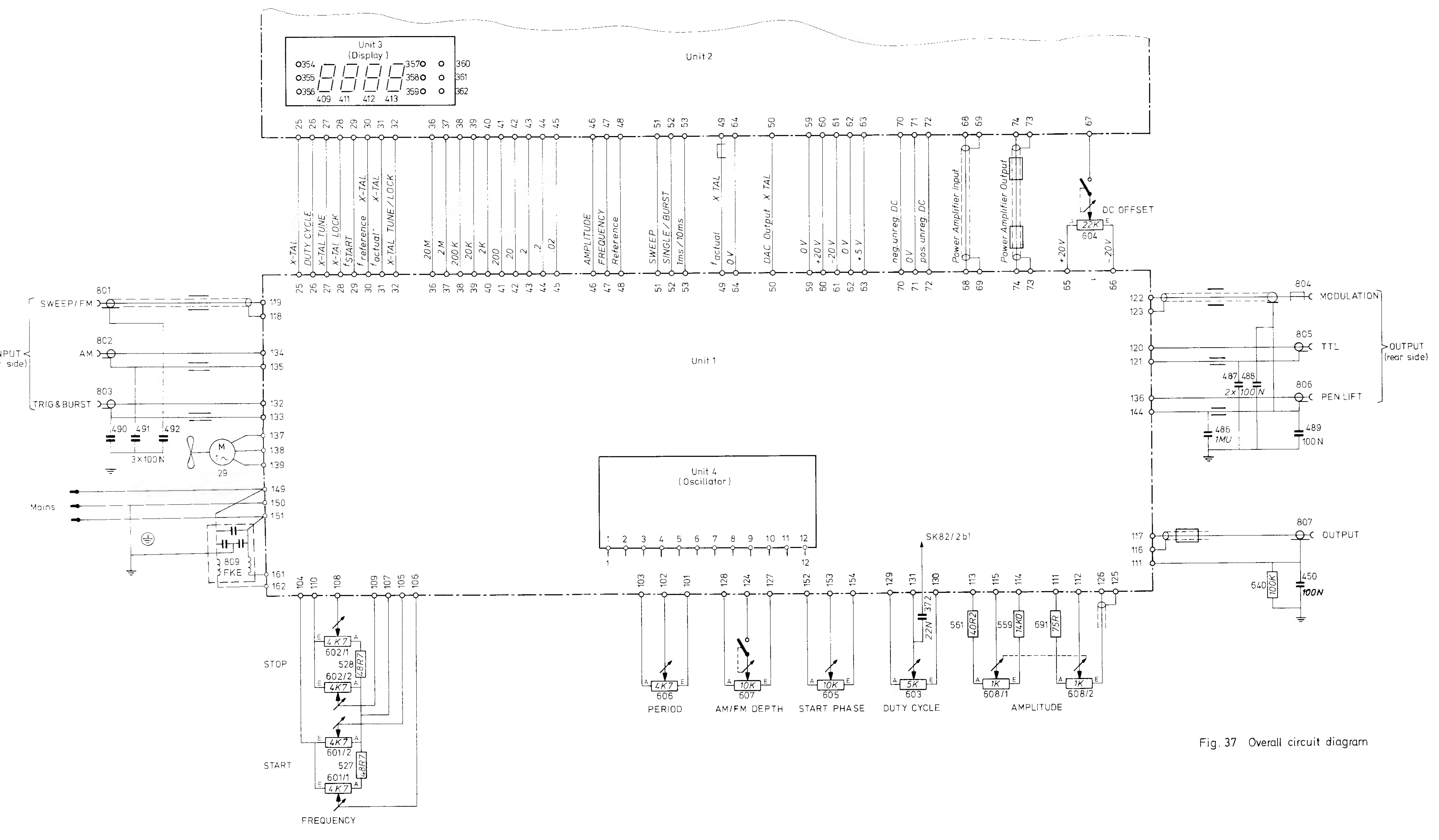


Fig. 37 Overall circuit diagram

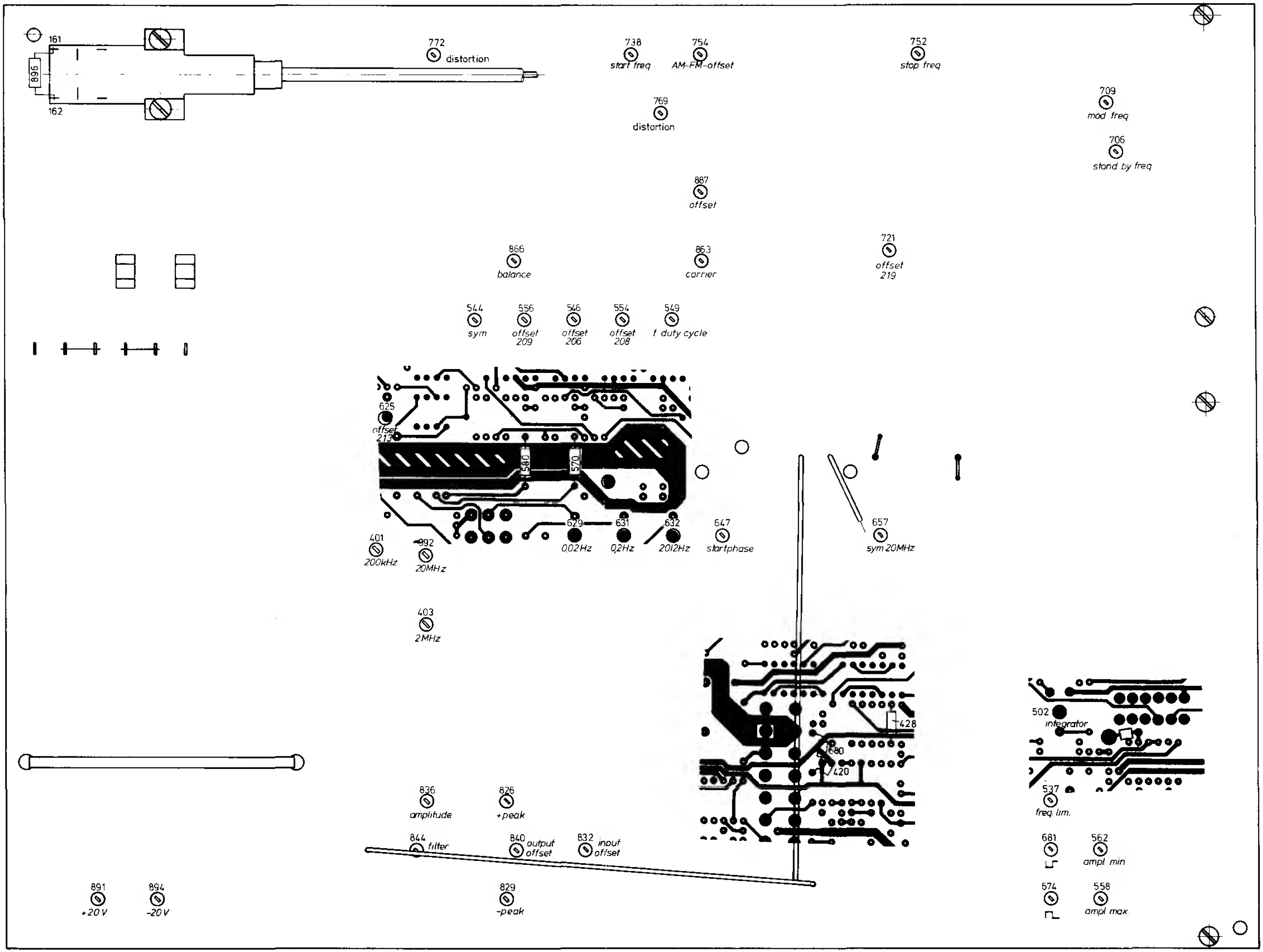
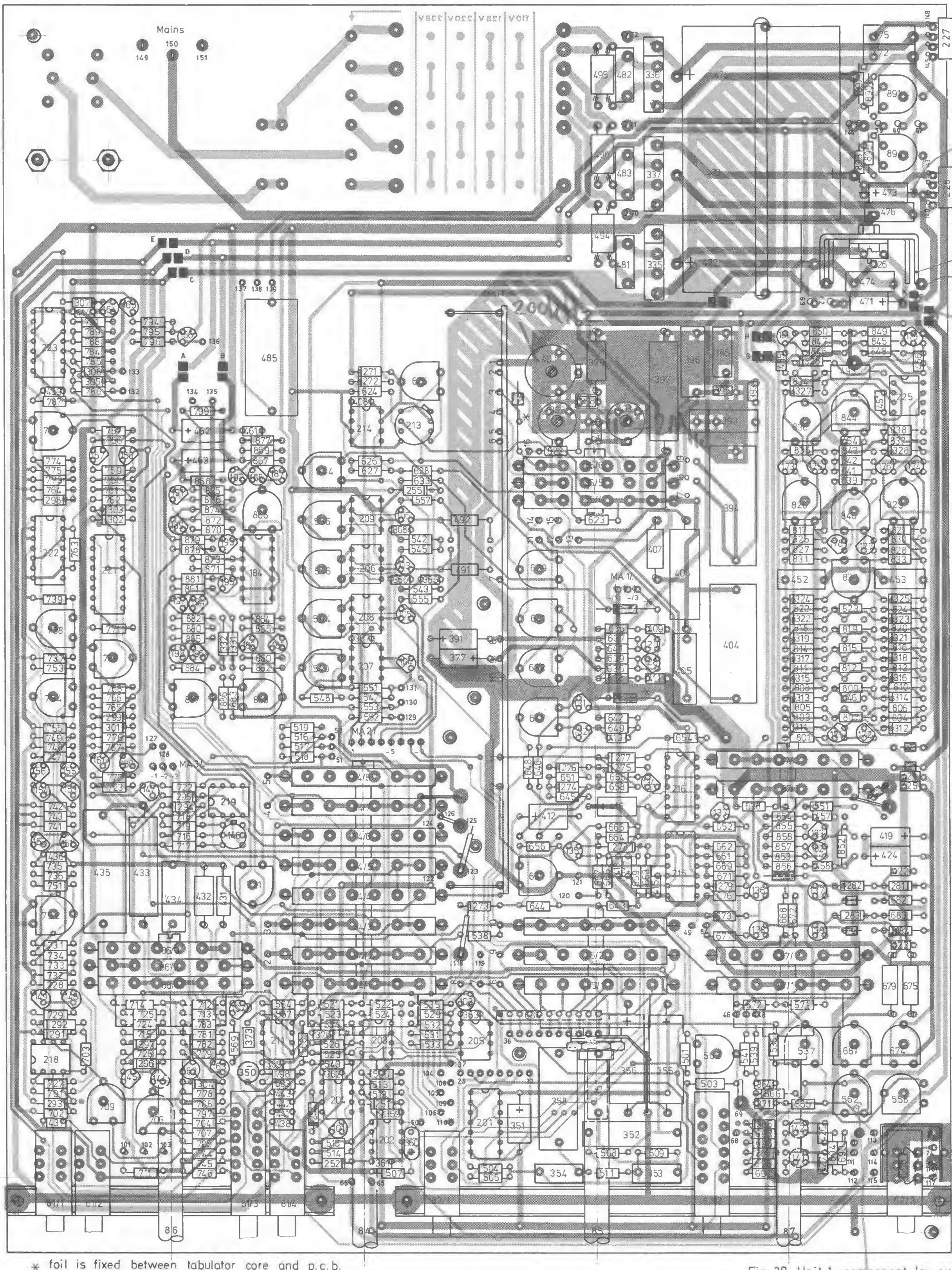


Fig. 38 Unit 1, adjusting elements



* foil is fixed between tabulator core and p.c.b.

Fig. 39, Unit 1, component lay-out

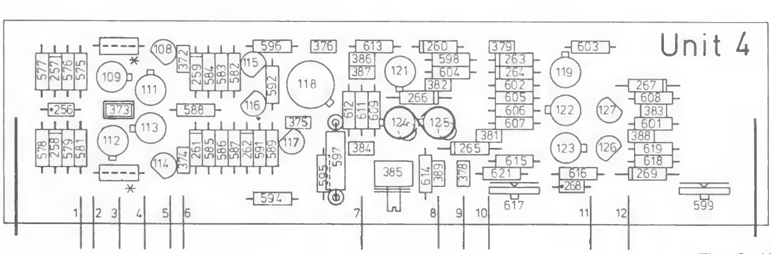
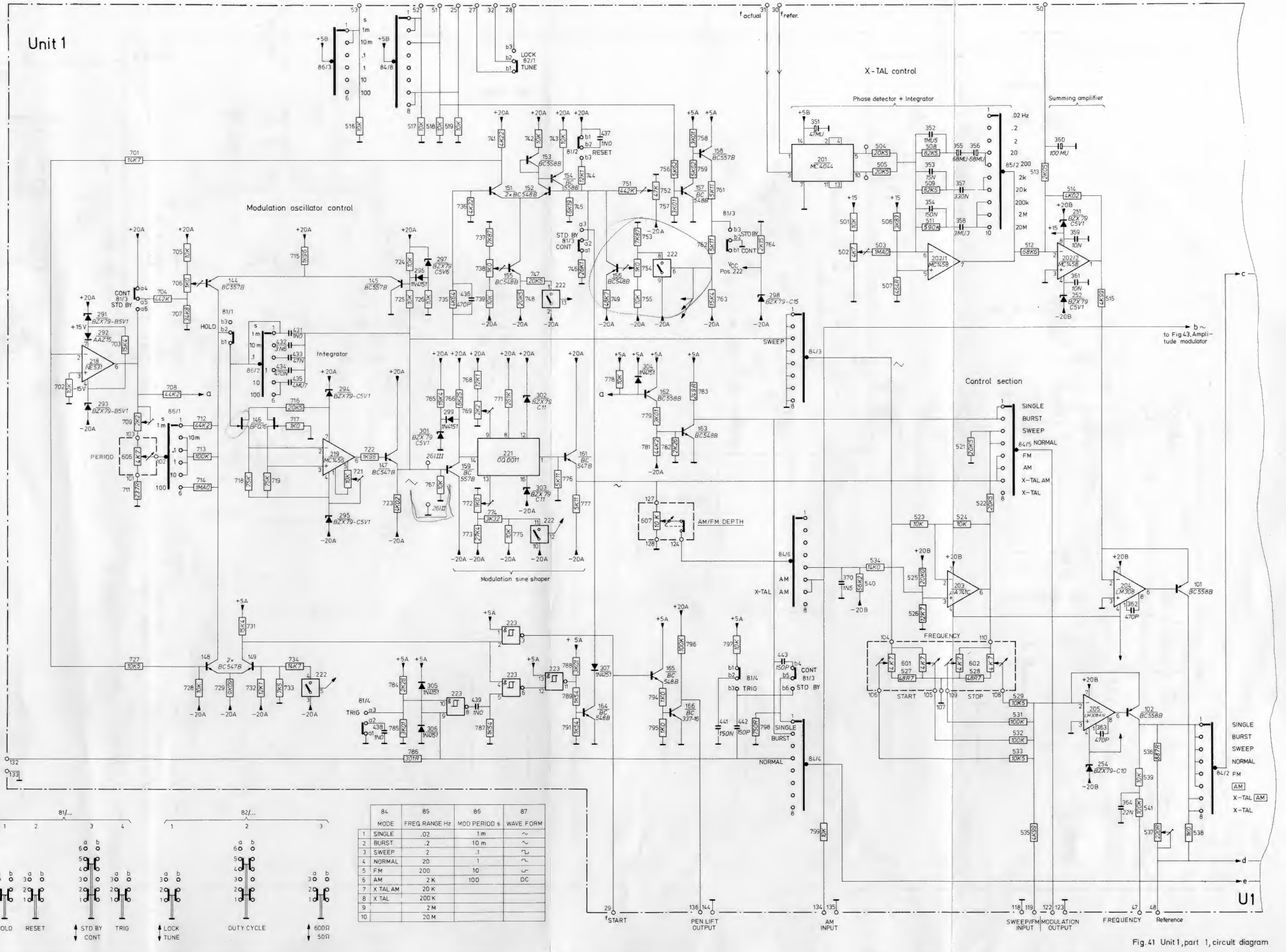


Fig. 40 Unit 4, component lay-out



	84 MODE	85 FREQ RANGE Hz	86 MOD PERIOD s	87 WAVE FORM
1	SINGLE	.02	1 m	~
2	BURST	.2	10 m	~
3	SWEEP	2	.1	
4	NORMAL	20	1	
5	FM	200	10	
6	AM	2 K	100	DC
7	X TAL AM	20 K		
8	X TAL	200 K		
9		2 M		
10		20 M		

Fig. 41 Unit 1, part 1, circuit diagram

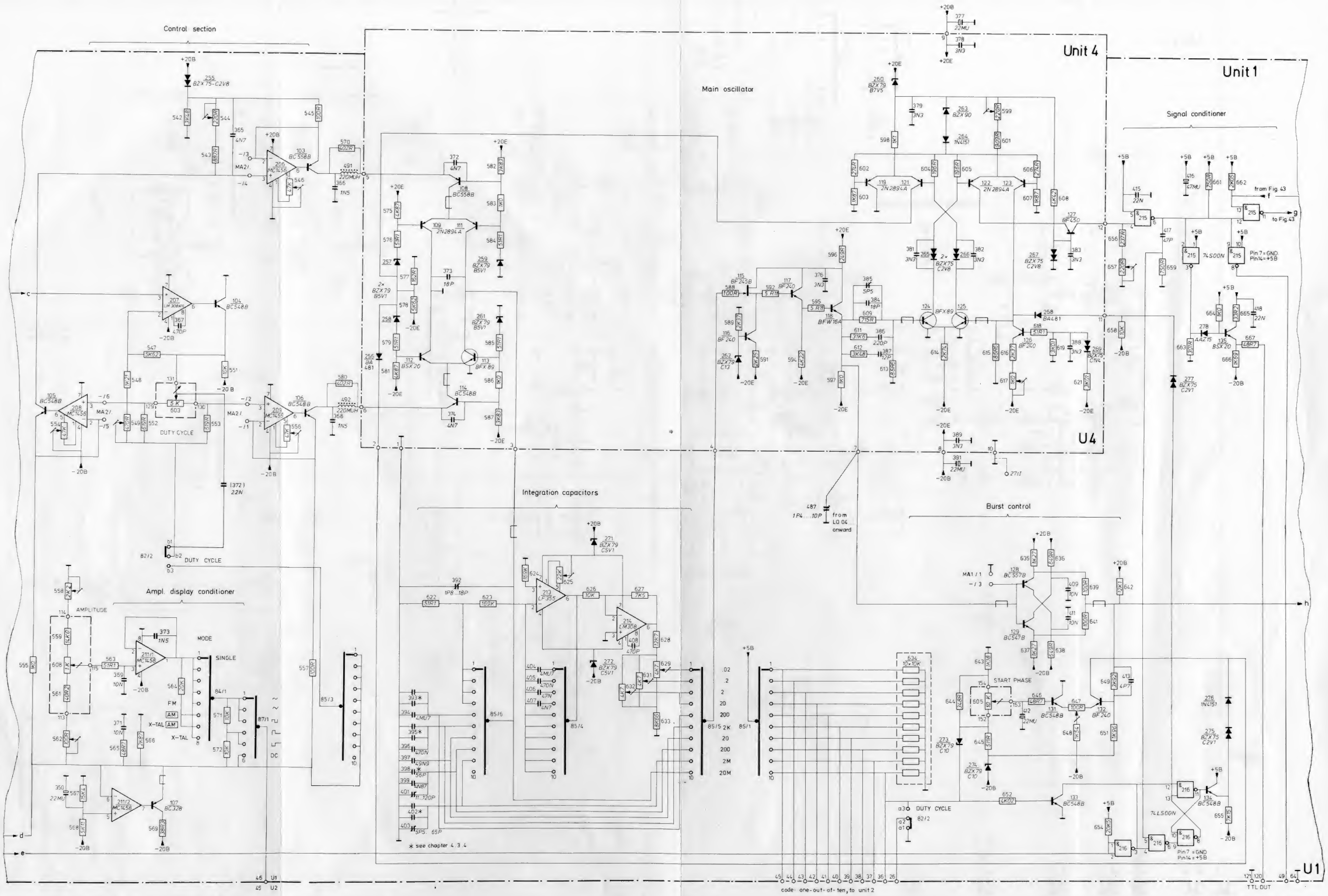


Fig. 42 Unit 1, part 2, circuit diagram

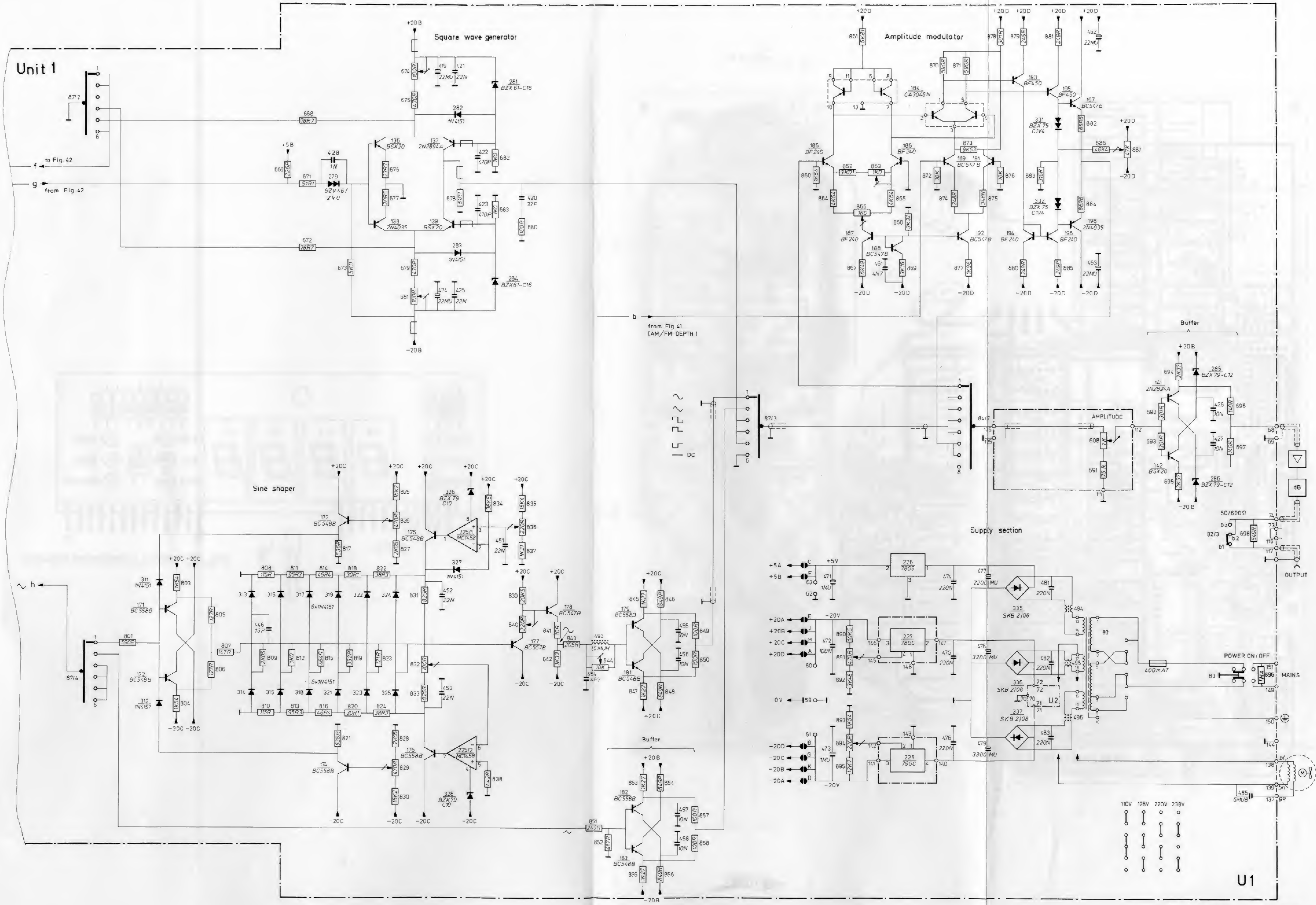


Fig. 43 Unit 1, part 3, circuit diagram

(ct 2.) Offset Adj

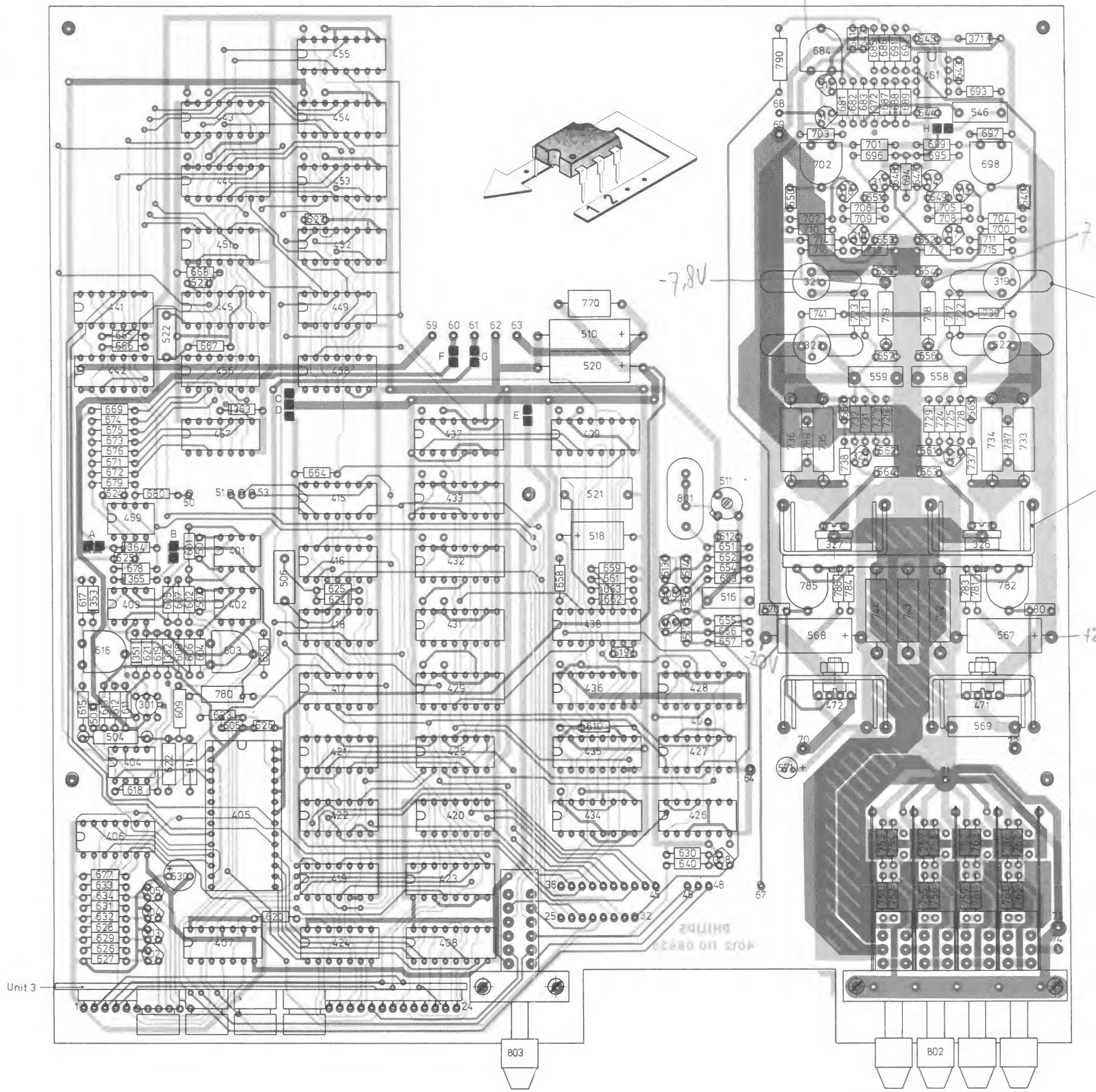


Fig.44 Unit 2, component lay-out

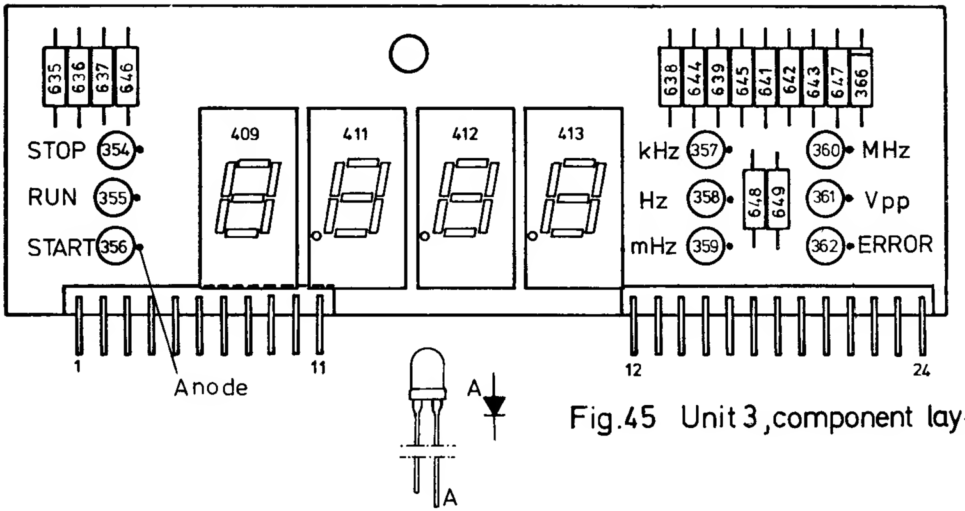
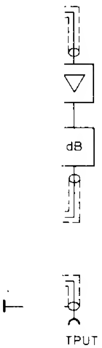


Fig.45 Unit 3, component lay-out



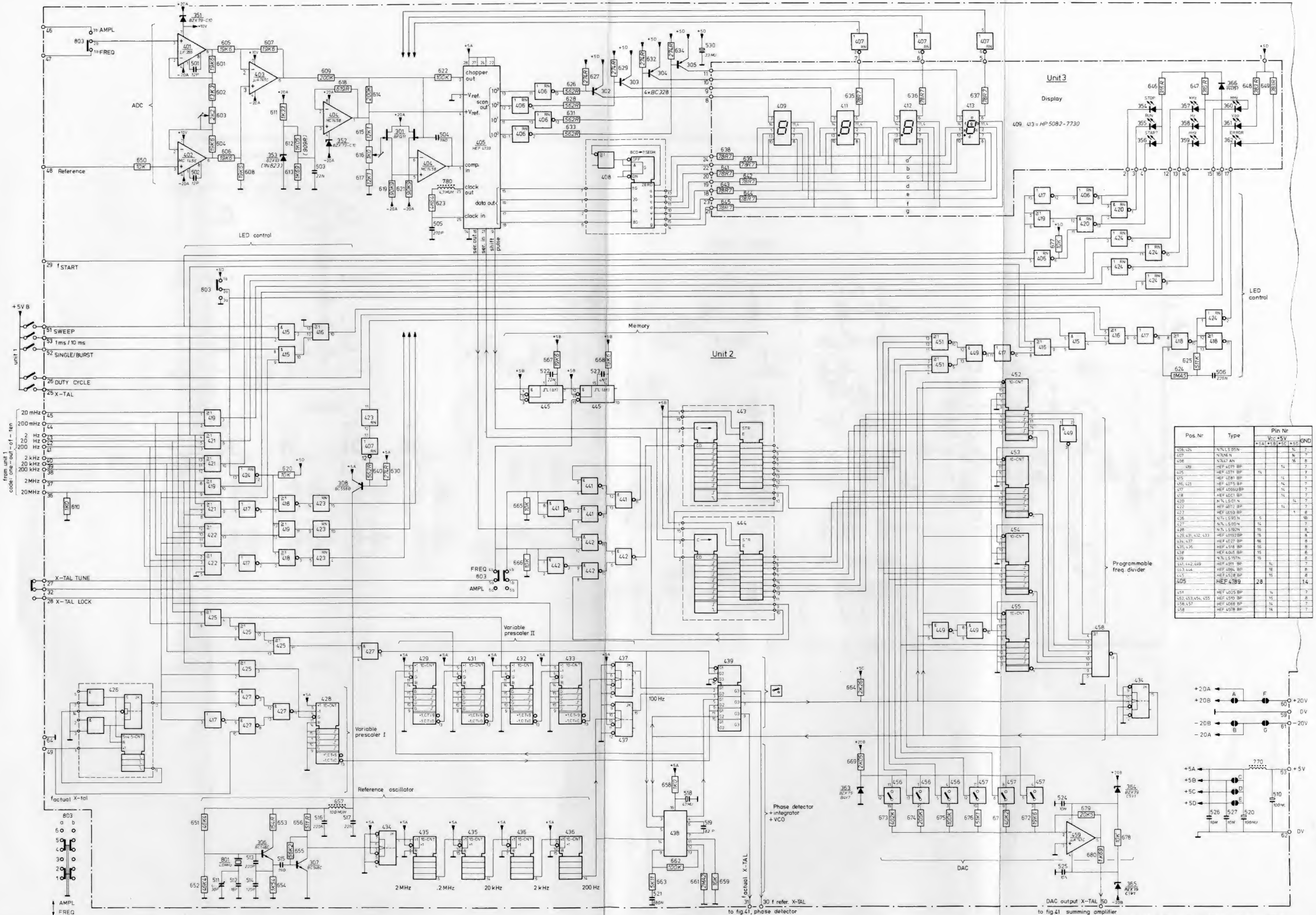


Fig.46 Unit 2, part 1; Unit 3; circuit diagram

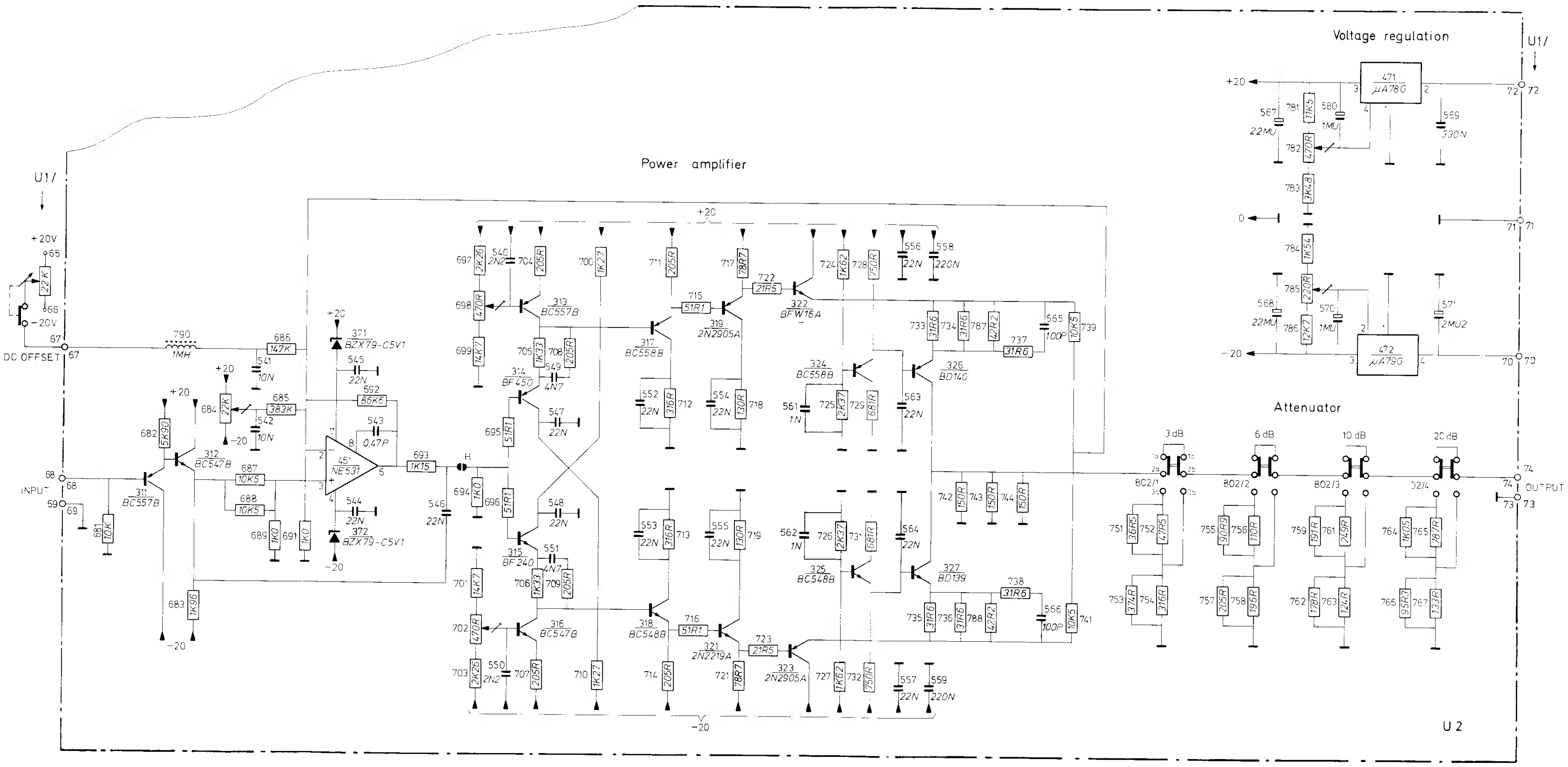


Fig. 47 Unit 2, part 2, circuit diagram

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① *Country*	② *Day Month Year*	③ *Typenumber /Version*	④ *Factory/Serial no.*
3 2	1 5 0 4 7 5	0 P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ *Nature of call*	*Location*	*Component/sequence no.*	*Category*
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ ☐☐ 1 2 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 3 2 = Switzerland

②Day Month Year 1 5 0 4 7 5 = 15 April 1975

③Type number/Version O P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number D O 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤Nature of call: Enter a cross in the relevant box

⑥Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve, transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦Job completed: Enter a cross when the job has been completed.

⑧Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐ 1 2 = 1,2 working hours (1 h 12 min.)

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